IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

First Named Inventor:	Lyn Rosenboom	Docket: 457009-2	
Application No.:	09/847,264	Confirmation No.	6915
Filing Date:	May 2, 2001	Group Art Unit:	3671
Title:	AGRICULTURE IMPLEMENT FRAME, TRACK ASSEMBLY AND CART (as amended)	Examiner:	Jamie L. McGowan

Board of Patent Appeals and Interferences
P.O. Box 1450
Alexandria, VA 22313-1450

RESPONSE TO NOTIFICATION OF NON-COMPLIANT APPEAL BRIEF

This paper is being filed in response to the Notification of Non-Compliant Appeal Brief dated June 18, 2009. Applicant believes no additional fees are due in connection with this response. However, in the event a discrepancy exists, please charge or credit any difference to the undersigned's Deposit Account No. 502498, referencing client/matter number 457009-2.

Amended Evidence Appendix is attached on a separate page and lists the evidence relied upon by the Applicant in the above referenced appeal, and a statement setting forth where that evidence was entered into the record by the Examiner, relied upon by the Examiner as to grounds of rejection, and copies of the listed evidence relied upon by the Examiner in accordance with 37 C.F.R. 41.37(c)(1)(ix) and MPEP 1205.02.

CERTIFICATE OF MAILING BY EFS-WEB FILING
I hereby certify that this paper was filed with the Patent and Trademark Office using the EFS-WEB system on June 22, 2009 by Carol McFadden

In view of the foregoing, it is respectfully submitted that this Appeal Brief is now compliant as the non-compliant appendices have been corrected and attached as replacement sections as requested in the Notification of Non-Compliant Appeal Brief dated June 18, 2009.

Should the Examiner have any further point of objection or need for additional information, the Examiner is urged to contact the undersigned via telephone.

Date: June 22, 2009

Respectfully submitted,

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(ix) EVIDENCE APPENDIX (AMENDED JUNE 22, 2009)

Applicant submits hereto the following United States Patents entered by the Examiner and relied upon in this appeal:

(1) U.S. Patent No. 3,841,424 to Purcell et al., which was entered into the record by the Examiner as prior art in the Office Action having a mail date of December 19, 2007, and was relied upon by the Examiner as grounds of rejection in the Office Actions having mail dates of December 19, 2007 and June 23, 2008.

(2) U.S. Patent No. 5,373,909 to Dow et al., which was entered into the record by the Examiner as prior art in the Office Action having a mail date of March 16, 2004, and was relied upon by the Examiner as grounds of rejection in the Office Actions having mail dates of December 19, 2007 and June 23, 2008.

(3) U.S. Patent No. 4,537,267 to Satzler, which was entered into the record by the Examiner as prior art in the Office Action having a mail date of December 19, 2007, and was relied upon by the Examiner as grounds of rejection in the Office Actions having mail dates of December 19, 2007 and June 23, 2008.

(4) U.S. Patent No. 6,318,484 to Lykken et al., which was entered into the record by the Examiner as prior art in the Office Action having a mail date of January 27, 2003, and was relied upon by the Examiner as grounds of rejection in the Office Actions having mail dates of January 27, 2003, March 16, 2004, August 1, 2005, May 1, 2006, November 9, 2006 and June 23, 2008.

United States Patent [19]

Purcell et al.

[11] **3,841,424**

[45] **Oct. 15, 1974**

[54] **TRIANGULAR TRACK RESILIENT BOGIE SUSPENSION**

[75] Inventors: **Robert J. Purcell**, Washington; **Kenneth E. Wehr**, Pekin, both of Ill.

[73] Assignee: **Caterpillar Tractor Co.**, Peoria, Ill.

[22] Filed: **June 22, 1973**

[21] Appl. No.: **372,829**

Related U.S. Application Data

[62] Division of Ser. No. 212,396, Dec. 27, 1971.

[52] **U.S. Cl.** **180/9.5,** 305/22

[51] **Int. Cl.** **B62d 65/12**

[58] **Field of Search** 180/9.5, 9.62; 305/25, 305/22, 29

[56] **References Cited**

UNITED STATES PATENTS

2,467,947	4/1949	Skelton	305/22 X
3,082,044	3/1963	Klemm	305/25 X
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FOREIGN PATENTS OR APPLICATIONS

844,768	8/1960	Great Britain	305/22
605,814	7/1948	Great Britain	305/25

Primary Examiner—Philip Goodman
Attorney, Agent, or Firm—Phillips, Moore, Weissenberger, Lempio & Strabala

[57] **ABSTRACT**

An assembly for supporting and driving a vehicle with a crawler track has the track chain engaged on a pair of spaced apart idler wheels and a drive sprocket situated between the idlers and upwardly therefrom whereby the chain is maintained in a triangular configuration with the sprocket and drive elements situated well above the abrasive conditions at ground level, the entire assembly being oscillatable relative to the associated vehicle.

To provide good resiliency and recoiling ability under high speed, heavy duty conditions each idler is mounted on one leg of an angled member which is pivoted to a fluid shock absorbing cylinder attached to an oscillatable track frame. Resilient means acting on the other leg comprises compression pads exhibiting a progressive spring rate whereby the idler may shift upwardly or backwardly as necessary to absorb shocks and reduce wear.

Pairs of load carrying track rollers are mounted on bogies pivoted to the other leg of the angled member. In an alternate embodiment the track roller bogies are pivoted directly to the oscillatable track frame.

14 Claims, 11 Drawing Figures

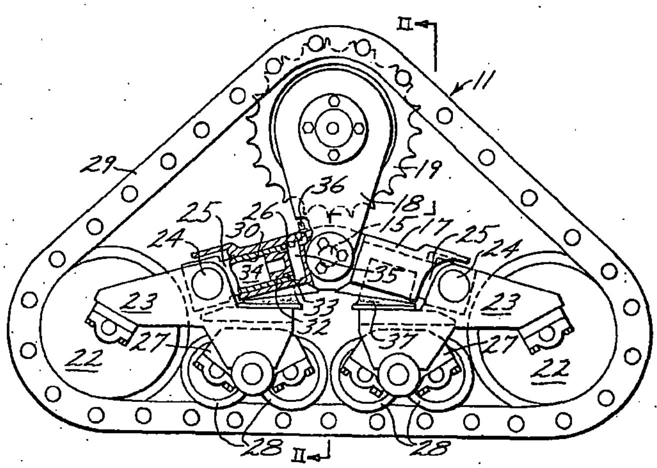


FIG. 1

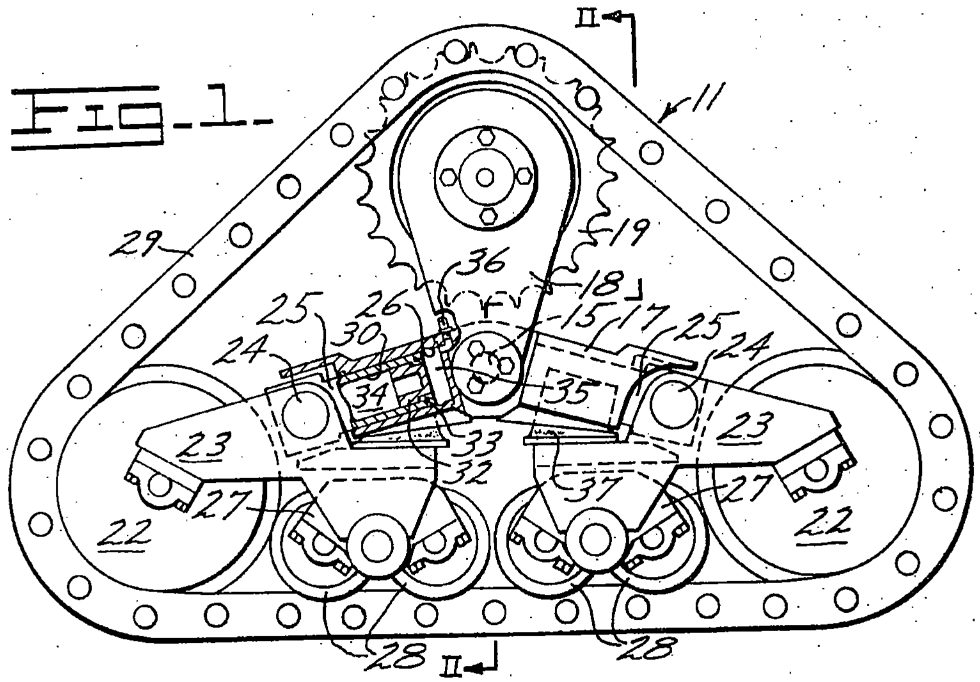
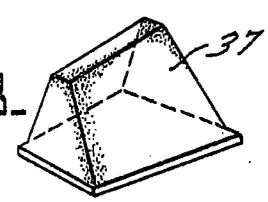


FIG. 3



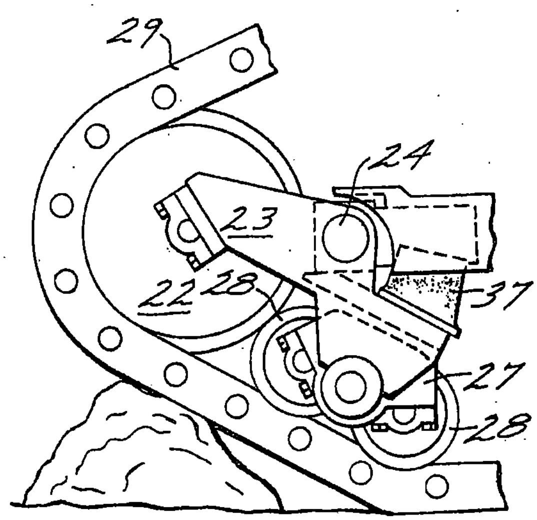


FIG. 5

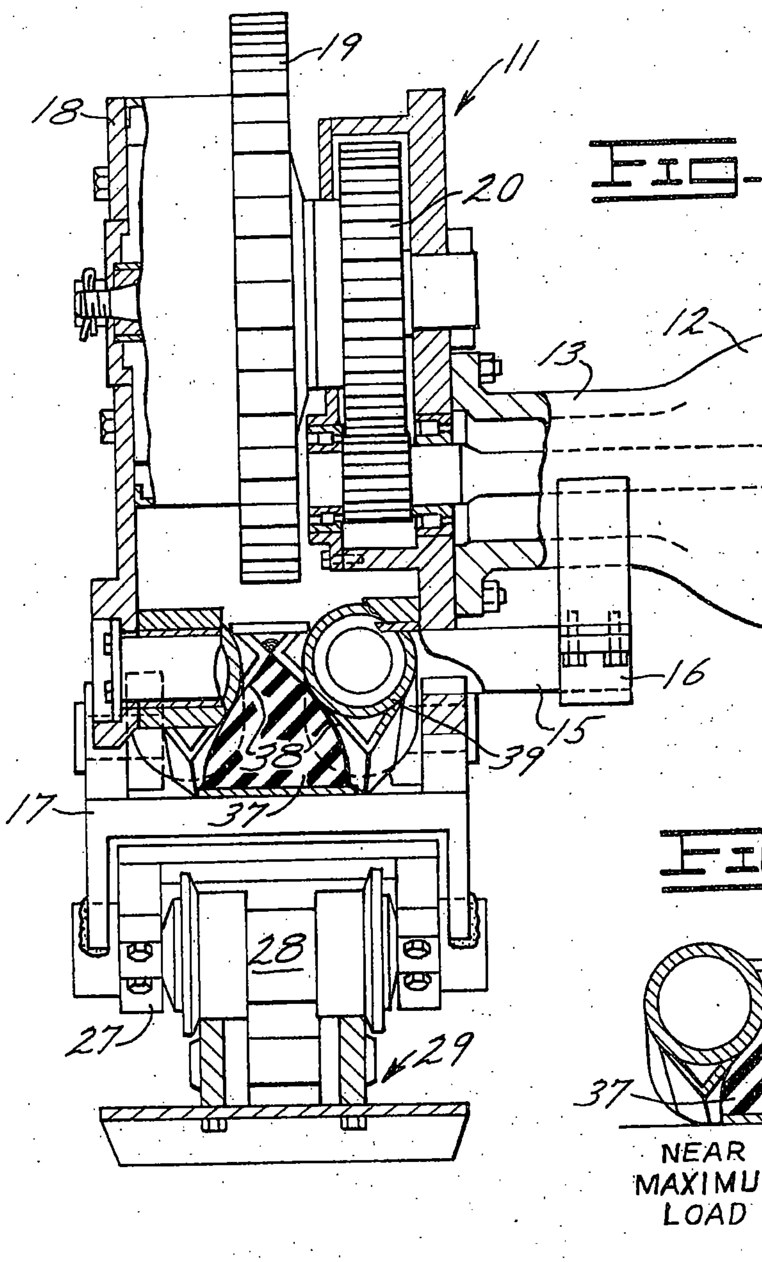

19
11
18
20
12
13
14
16
15
39
38
37
17
28
27
29

FIG-2-

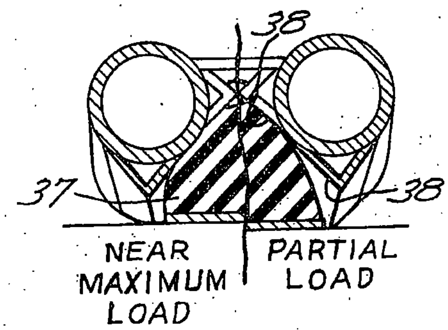
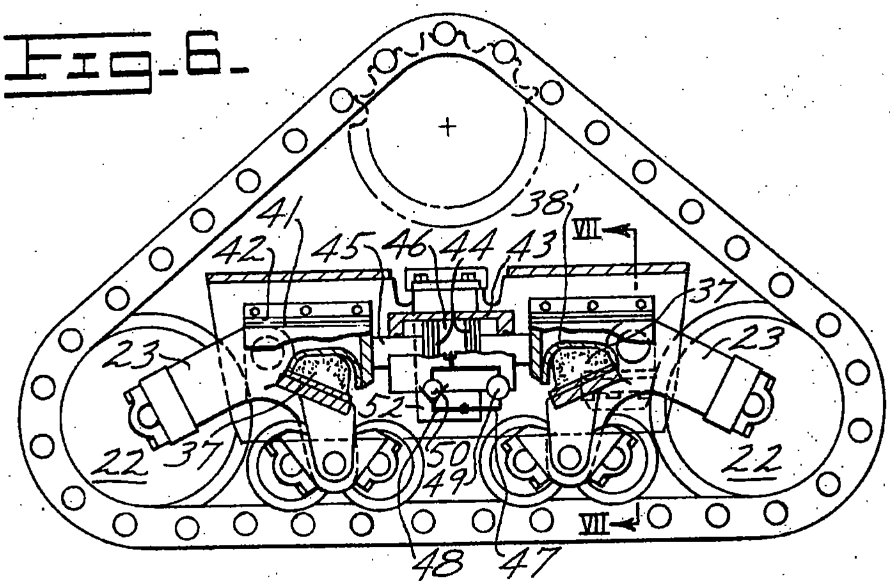

38
37
38
NEAR MAXIMUM LOAD
PARTIAL LOAD

FIG-4-

Fig. 6


41
42
45
46
44
43
38'
VII
37
23
23
22
22
37
52
50
49
48
47
VII

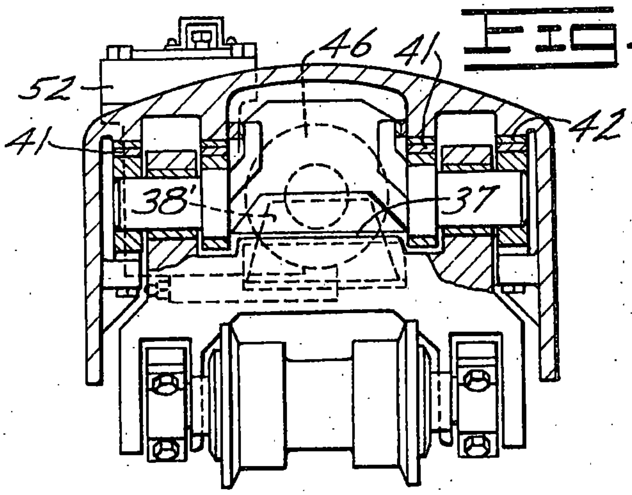

52
46
41
41
42
38'
37

Fig. 7

FIG. 8

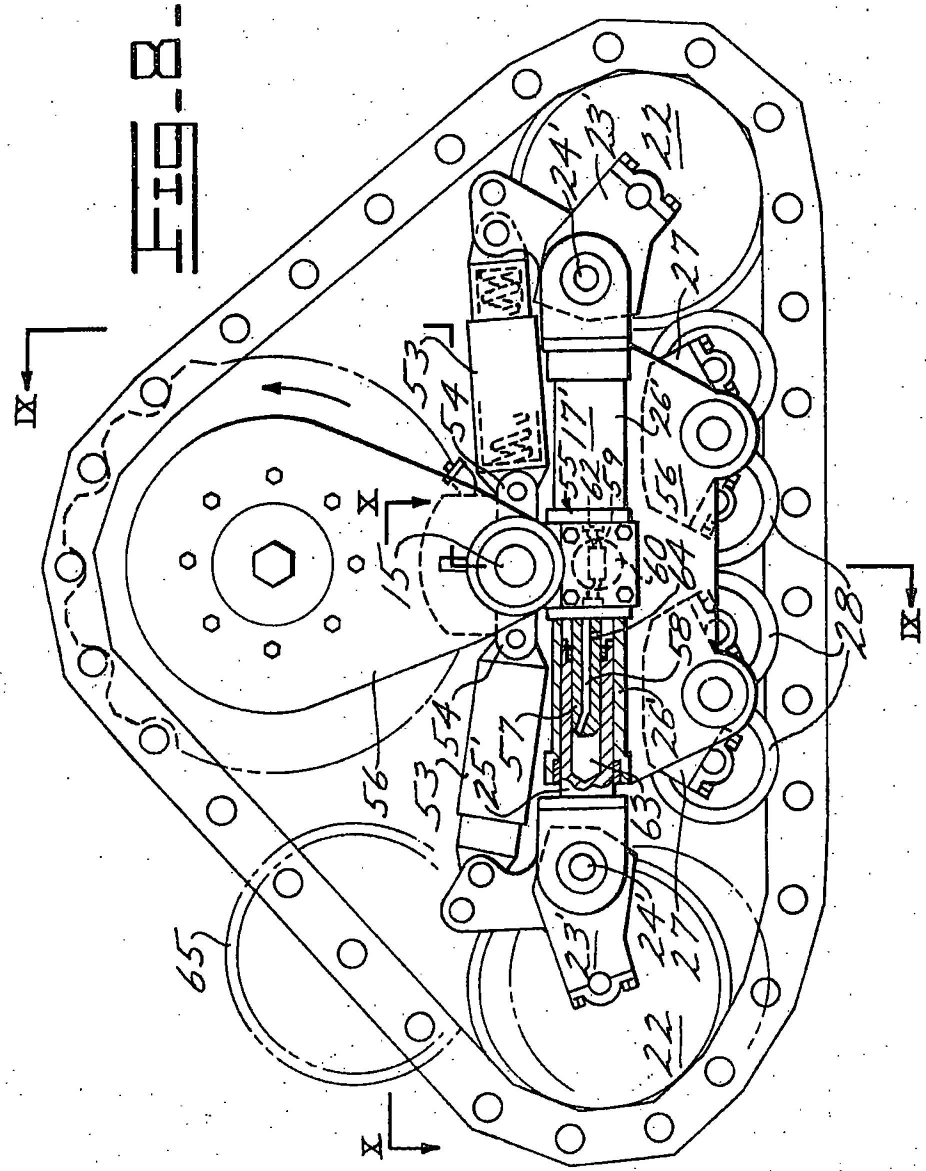


Fig. 9.

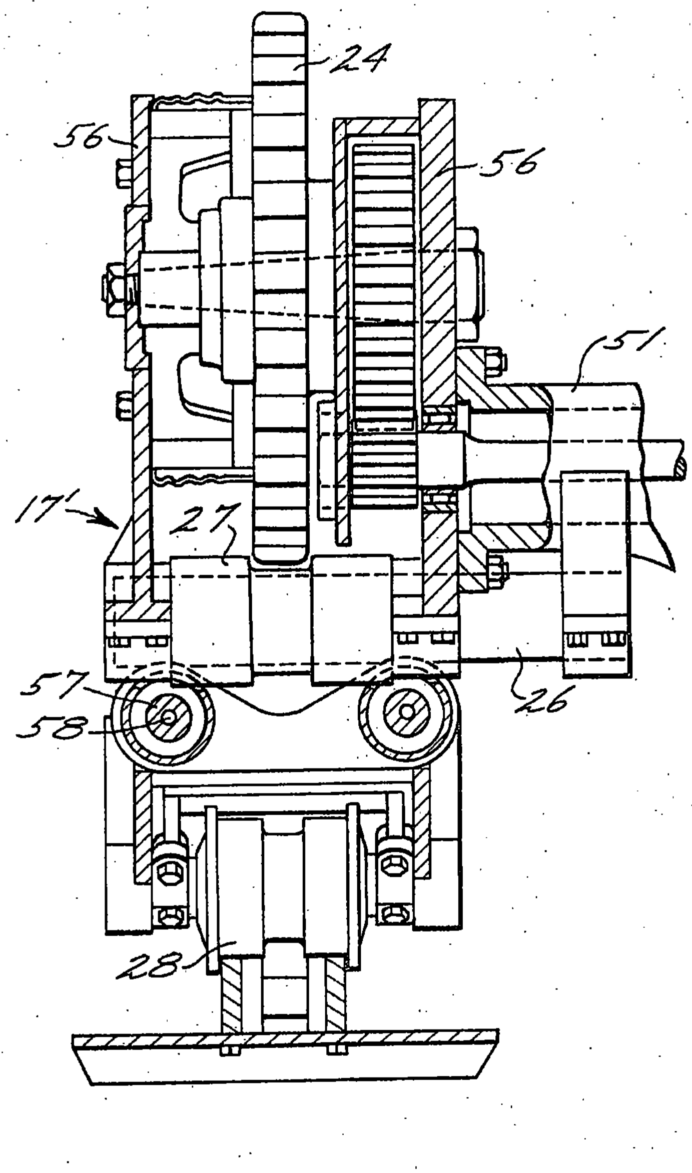
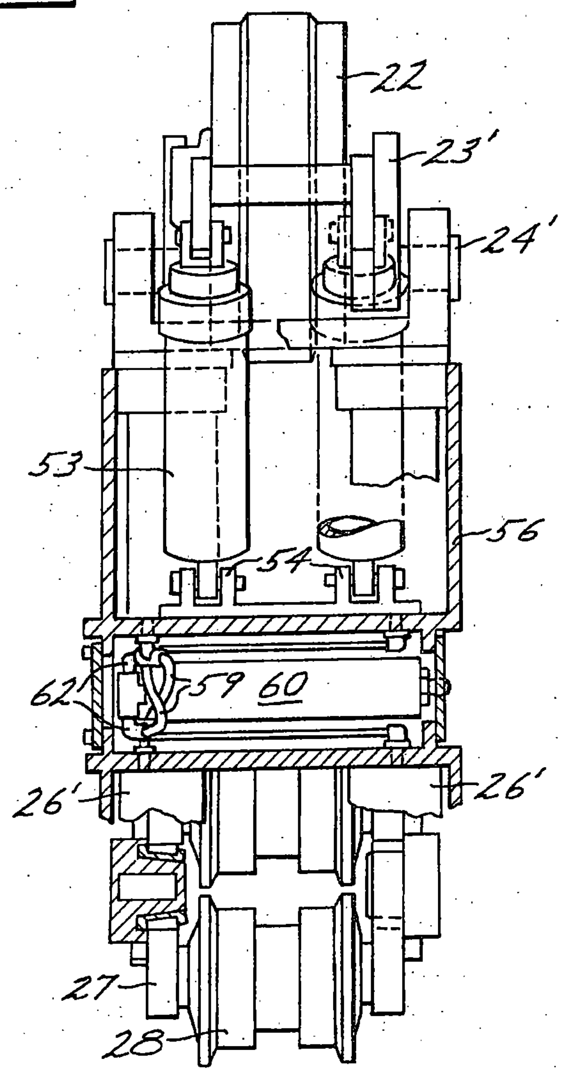


Fig.10.



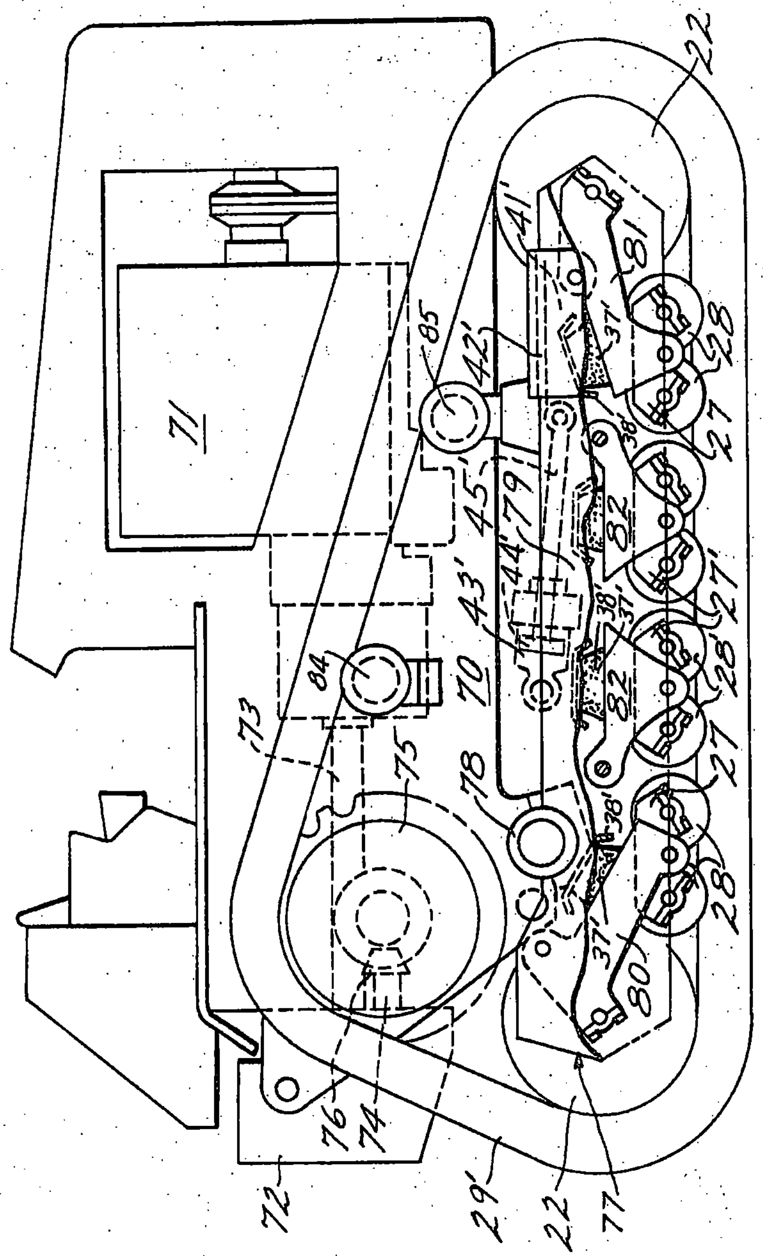

22
41'
81
37'
28
85
42'
27
38'
71
79'
45'
82
44'
43'
27'
70
84
73
75
78
80
76
74
72
29'
77

FIG. 11

TRIANGULAR TRACK RESILIENT BOGIE SUSPENSION

This is a division, of Ser. No. 212,396, Filed Dec. 27, 1971.

BACKGROUND OF THE INVENTION

This invention relates to crawler vehicles and more particularly to track chain suspensions therefor.

The track chain of most commercial crawler vehicles is usually engaged on a pair of large longitudinally spaced wheels wherein the forward wheel is an idler and the rear wheel is toothed and constitutes the drive sprocket for the chain; smaller roller wheels being distributed between the two major wheels for support and load bearing purposes. It has been recognized that this close proximity of the sprocket and associated drive elements to ground level has adverse effects on durability and other performance factors when highly abrasive conditions are present. Also, such an arrangement requires the vehicle driving sprocket to endure a part of the load of the vehicle as well as driving forces for propelling the vehicle.

To alleviate these problems, track suspensions have heretofore been designed in which the chain is engaged upon two longitudinally spaced idlers with the drive sprocket being a third wheel situated between the two idlers and upwardly therefrom so that the chain is maintained in a substantially triangular configuration, with the sensitive drive elements being well above the ground and relieved of the load forces associated with supporting the vehicle. It has heretofore been recognized that such a configuration may provide greater durability and lessen maintenance problems.

In order to provide for the absorption of shock and for an aggressive, efficient driving action and to provide for maintenance of track chain tension and vehicle stability, the chain supporting elements should be resiliently mounted. Triangular track chain suspensions as heretofore constructed have either lacked the desired degree of resiliency and recoiling ability or have been unduly complex, heavy and costly.

SUMMARY OF THE INVENTION

The present invention is a powered crawler vehicle track chain assembly of the triangular form discussed above which is characterized by extreme resiliency and recoiling ability with a resultant reduction in wear, increased absorption of shock, and provision of an aggressive, efficient driving action on rough terrain and increased speed of operation. The chain is engaged upon longitudinally spaced front and rear idlers and an intermediate elevated drive sprocket is an arrangement wherein the idlers are attached to an oscillatable track frame through a pivotal connection to a fluid shock absorber on the track frame, providing for an essentially longitudinal recoil; and wherein resilient means act on the idler to cushion essentially vertical movements.

Accordingly it is an object of this invention to provide a track chain assembly for crawler vehicles of the form having an elevated drive sprocket between two longitudinally spaced idlers wherein the track exhibits a high degree of resiliency and recoiling ability for operation under difficult conditions.

The invention together with further objects and advantages thereof will best be understood by reference to the following description of preferred embodiments in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

In the accompanying drawings:

FIG. 1 is a side elevation view of a first embodiment of a crawler vehicle track chain assembly in accordance with the invention with portions of the mechanism broken out;

FIG. 2 is a sectioned view taken along staggered line II—II of FIG. 1;

FIG. 3 is a perspective view of a resilient element utilized in the track chain assembly of FIGS. 1 and 2;

FIG. 4 is a sectional view of a portion of the mechanism of FIGS. 1 and 2 showing the deformation of a resilient element thereof which occurs under certain operating conditions to be described;

FIG. 5 is a view of a portion of the mechanism shown at FIG. 1 illustrating effects which occur when the track chain assembly encounters an obstacle;

FIG. 6 is a side elevation view of a second embodiment of a crawler vehicle track assembly;

FIG. 7 is a sectioned view taken along the line VII—VII of FIG. 6;

FIG. 8 is a side elevation view of still another crawler vehicle track chain assembly constituting a third embodiment of the invention;

FIG. 9 is an elevation section view of the mechanism of FIG. 8 taken along line IX—IX thereof;

FIG. 10 is a plan section view of the mechanism of FIG. 8 taken along line X—X thereof; and,

FIG. 11 is a side elevation of another crawler vehicle illustrating still another embodiment of the present invention.

DESCRIPTION OF PREFERRED EMBODIMENTS

Referring now to the drawings and more particularly to FIGS. 1 and 2 thereof in conjunction, the track chain assembly 11 of the present invention may be utilized with any of the diverse known forms of crawler vehicles and accordingly only a small portion 12 of such a vehicle is shown for purposes of reference. A suitable vehicle of this form is disclosed, for example, in U.S. Pat. No. 3,435,908.

To attach the ground engaging means to such a vehicle, the vehicle is usually equipped with a sidewardly projecting tubular axle housing 13 having a power drive axle 14 extending axially therefrom. The form of axle housing 13 and drive axle 14 depicted in FIGS. 1 and 2 is commonly employed on certain commercially available articulated earth moving vehicles and was originally designed and is normally employed for attaching powered wheels to the vehicle. The track chain assembly 11 of the present invention is designed to replace such wheels without requiring any major modification of the vehicle itself including the axle housing 13 and drive axle 14.

To attach track chain assembly 11 to the vehicle, a main pivot shaft 15 is secured to the end of the axle housing 13 by a bracket 16 and housing 18. A track frame 17 is oscillatably carried on the pivot shaft and has ends which extend forwardly and rearwardly from the shaft.

Also secured to the end of the axle housing 13 is a housing 18 rotatably mounting a drive sprocket 19 which is connected to drive axle 14 through reduction

gearing 20 mounted in housing 18 adjacent the drive sprocket.

Front and rear idlers 22 are rotatably mounted on one end of idler support members comprising cranks 23 which are pivotally and reciprocally mounted at intermediate points on the forwardly and rearwardly extending ends of track frame 17 by means of trunnions 24 attached to recoil pistons 25 slidable within hydropneumatic cylinders 26 provided in the track frame ends.

Bogies 27 are pivotally mounted on the other ends of cranks 23. The bogies in turn carry pairs of track rollers 28 which support the vehicle.

A conventional track chain 29 encompasses idlers 22, track rollers 28 and drive sprocket 19 and is maintained at a proper operating tension by the hydropneumatic cylinders 26. Pistons 25, which are disposed within cylinders 26 in turn have cylinders 30 provided therein. Pilot pistons 32 slidable in cylinders 30 against a retainer 33, define gas precharge chambers 34 which are filled with gas at a pressure sufficient to maintain the track at the proper operating tension.

Piston 25, pilot pistons 32 disposed within pistons 25, and cylinders 26 define a fluid chamber 35 which is filled with sufficient fluid to maintain the track chain 29 at the proper operating tension. Chambers 35 may be filled with fluid by means of conduits 36.

When a foreign object gets between the track and an idler, retraction of an idler is necessary to prevent excessive tension in the track chain. The foreign object, bearing on the idler, will urge piston 25 inwardly against the pressure of the fluid in chamber 35. The resulting increased fluid pressure in chamber 35 displaces pilot piston 32 against the gas precharge in chamber 34, permitting piston 25 to slide inwardly into cylinder 26, and allowing recoil of the idler 22.

After the object has been ejected, the gas pressure in chamber 34 returns piston 32 against retainer 33, causing the fluid in chamber 35 to return piston 25 and idler 22 to their initial positions.

Cushioning of the track rollers is provided by wedge-shaped compression pads 37 disposed on the upper surfaces of the bogey-supporting ends of the cranks 23. The compression pads project upwardly between the cylinders 26 where they are engagable by plates 38 which are an integral part of cylinder housings 39 enclosing cylinders 26.

As shown in FIG. 3, each compression pad 37 comprises a resilient rubber block which tapers upwardly. Plates 38 diverge downwardly at a greater angle than the upward taper of the pads. Thus, as illustrated in FIG. 4, the shape of compression pad 37 and plates 38 are so related that as th pads move toward the plates, they are initially engaged by the plates only at the apex of the pads.

As the upper portion of the pads compresses upon further movement toward the plates, a progressively greater portion of the pads is engaged by the plates. As a result, compression pads 37 exhibit a progressive spring rate as they cushion upward deflection of the track rollers 28.

Due to the configuration of the track chain mounted on the track suspension of the present invention, a relatively light track tension is required for effective driving engagement of the track by the driving sprocket 19. Accordingly, the spring rate of the idler recoil pistons 25 may be low. As a result, a relatively large object may be easily overcome by relatively unrestrained vertical displacement of the lead idler until the track rollers and bogey encounter and absorb the entire load initiated by the obstacle.

The configuration of the track suspension of the present invention during negotiation of an obstacle is illustrated in FIG. 5.

As the idler ascends to overcome the obstacle, crank 23 pivots on trunnion 24, inherently urging the bogie-mounted rollers into a relatively light load area of the track. Consequently, the cycle time in which the track rollers pick-up the load encountered earlier by the track idler is shorter than in conventional track suspensions. The bogey-mounted rollers 28, in shifting forward, contribute to maintenance of proper track tension. Since the bogies are free to pivot on the crank 23, the track rollers encounter substantially lower shock loads than normal track rollers because of the bridging action afforded by the taut track.

As the obstacle is overcome, the crank 23 pivots on trunnion 24, returning the track rollers and idler to their original positions, at which time the rubber compression pads 37 return to engagement with plates 38, cushioning the track rollers as they pass over the obstacle.

As the load is absorbed by the track rollers, progressive deflection or compression of the pad will occur in the manner shown in FIG. 4 until it occupies substantially all of the nesting area between the two plates 38.

Upon initial contact with the obstacle, the forward idler and crank rotate on trunnion 24 to effect an advantageous change in the moment arm and load forces acting upon the suspension. The low spring rate allows the front idler and track to overcome an obstacle through a very aggressive effort of the track. The bridging action of the track rollers reduces substantially the load on the idler and the track rollers. In tests it has been found that this bridging action can reduce roller loads from a 37,000/87,000 pound range to a 14,000/22,000 pound range.

An alternative embodiment of an idler recoil mechanism that may be employed in the triangular track suspension of the present invention to eliminate detrimental shear and abrasive wear of the compression pads 37 is shown in FIG. 6.

Another advantage of this embodiment is the use of a single, dual-purpose recoil cylinder to accommodate both front and rear idlers. In this embodiment, the cranks 23 are rotatably mounted on slide bearings 41 which are mounted for reciprocal movement on slides 42. Compression pads 37, mounted on the cranks 23, are engageable by plates 38' integrally formed on the slide bearings 41. Since the plates 38' recoil with the cranks 23, the compression pads 37 will not be subject to shear forces and abrasive conditions that would otherwise be encountered when the cranks recoil.

A single recoil cylinder 43 accommodates both the front and rear idlers. Pistons 44 disposed within the recoil cylinder have rods 45 extending therefrom which engage the slide bearings 41. Recoil cylinder 43 and pistons 44 define a chamber 46 which is filled with pressurized fluid. Chamber 46 communicates with an accumulator 52 through parallel conduits 47 and 48, having a relief valve 49 and a directional check valve 50 respectively disposed therein.

If a foreign object gets between an idler and the track, it will urge the idler and associated crank trunnion inwardly, moving a slide bearing **41**. The slide bearing, engaging a piston rod **45**, moves a piston **44** within the recoil cylinder **43** against the pressure fluid in the cylinder chamber **46** which is allowed to overcome relief walve **49** and bleed into accumulator **52**, allowing the idler to recoil. When the foreign object is expelled, fluid pressure in the accumulator communicates with chamber **46** through conduit **48** and check valve **50**.

Another embodiment of the present invention is shown in FIG. **8**. Idlers **22** are rotatably mounted on cranks **23'** which are pivotally mounted by means of trunnions **24'** on pistons **25'** slidable within hydropneumatic cylinders **26'** provided in oscillatable track frame **17'**. The cranks **23'** are preloaded and cushioned by preload springs **53** connected between the cranks and brackets **54** on main pivot shaft **15**.

Suitable brackets **55** and side plates **56**, forming the main structure of track frame **17'**, extend downwardly to permit two pairs of bogie-mounted track rollers **28** to be pivotally supported thereon.

The hydropneumatic cylinders **26'**, which provide for recoiling of the idlers, have stub shafts **57** disposed coaxially therein. Hollow tubular pistons **25'** are journaled for reciprocation within cylinders **26'** and on stub shafts **57**. Stub shafts **57** are provided with passages **58** and lines **59** for communication with a nitrogen-charged accumulator **60**. The precharge is sufficient to assure satisfactory pressure for the recoil mechanism and tension of the track. During driving of the track, inter-action with the suspension and sprocket automatically results in the rear or high loaded portion of the track being under tnsion which consequently results in the more lightly loaded front recoil cylinder **26'** extending sufficiently for recoiling purposes and simultaneously maintaining desired track tension. Accumulator **60** is arranged laterally within the track frame **17'** so that four lines **59** connected by fittings **62** may communicate pressure through passages **58** of shafts **57** to chambers **63** serving to load recoil pistons **25'** when passages **64** are covered by pistons **25'**.

In the event the direction of travel for the vehicle is reversed, the idler and piston previously in the rear will automatically extend while the piston and idler previously in the lead will automatically retract to compensate for load readjustment.

Sufficient vertical oscillation is permitted each idler **22** through pivoting of cranks **23'** to overcome normal road obstacles, while oscillation of the entire track unit is accommodated by main pivot shaft **15**. In the position of maximum displacement, shown by phantom lines **65**, the track frame **17'** contacts positive stops (not shown) provided intermediate the vehicle axle housing.

In this embodiment, the specific geometry provided the track frame and idlers in relation to the drive sprocket is such that the load vectors or reaction force of each recoil linkage is balanced within the system. Normally there is sufficient torque reaction from the driving force that a pivotally mounted track tends to walk around the sprocket or support bearing if unbalanced loading exists. In the present arrangement the new mean line of force resulting from vertical oscillation and/or recoiling of the idlers falls just above the main pivot shaft **15**. With this inherent design advantage augmented by the weight distribution within the track nearly all detrimental reaction forces are neutralized. The particular arrangement of springs **53** and cranks **23'** also results in parallelogram-type action that assures satisfactory clearance, oscillation, and tension of the track.

Still another embodiment of the track suspension of the present invention is illustrated in FIG. **11**.

A tractor includes a frame **70**, an engine **71** mounted on the frame, transmission **72** also mounted on the frame, a crank shaft **73** for transmitting power from the engine to the transmission, and a drive shaft **74** extending from the transmission. A drive sprocket **75** is rotatably mounted on the tractor frame **70** and driven by a gear **76** mounted on the end of drive shaft **74**.

A track frame **77** is pivotally mounted on the tractor frame **70** by a pivot mounting **78**. In this embodiment, a single track frame **79** is mounted on each side of the tractor vehicle toward the rear of the vehicle. The forwardly extending end of the track frame with respect to the pivot mounting is greatly elongated, and the rearwardly extending end of the track frame is relatively short.

Idlers **22** are rotatably mounted on one end of idler support members comprising cranks **80** and **81** respectively, which in turn are mounted on the rearwardly and forwardly extending ends of track frame **79**. A bogie **27** is pivotally mounted on the other ends of crank **80** and **81**, and has track rollers **28** rotatably mounted thereon which engage a track chain **29'** encompassing idlers **22** and drive sprocket **75**. An intermediate point of crank **80** is pivotally mounted on track frame **79**.

Crank **81** has an intermediate point pivotally mounted on a slide **40'** which in turn is mounted for reciprocation on slide bearing **42'** mounted on track frame **79**. A push rod **45'** is connected between slide **41'** and a piston **44'** disposed in a recoil cylinder **43'** mounted on track frame **79** and constructed similar to recoil cylinder **43** already described.

For additional support of the suspension on the track, trailing links **82** having bogies **27'** pivotally mounted thereon, are also pivotally mounted on the track frame **79**. The bogies in turn rotatably mount track rollers **28'** which engage track chain **29'**.

Crank members **80** and **81** and links **82** all have resilient blocks **37'** mounted thereon for engagement with plates **38'** to cushion pivoting of the crank members and links when the track rollers pass over a bump. Blocks **37'** and plates **38'** are similar to blocks **37** and plates **38** previously described, exhibiting a progressive spring rate as the crank members and links pivot with respect to the track frame.

The forward portion of tractor frame **70** is resiliently supported on track frame **79** by conventional means not shown.

Small idlers **84** and **85** rotatably mounted on tractor frame **70** maintain the track chain **29'** in proper alignment between sprocket **75** and the forward idler **22**.

I claim:

1. A vehicle supporting and driving assembly for a vehicle having an axle housing and a drive axle in the axle housing comprising:
   - a main pivot shaft securable to said axle housing,
   - a track frame having an intermediate point secured to the main pivot shaft for pivotal oscillation of the track frame with respect to said axle housing, and

having first and second ends extending from said intermediate point,

idler support members at the first and second ends of the track frame,

means pivotally and reciprocably securing the idler support members to the track frame ends,

idlers rotatably mounted on the idler support members,

cushion means responsive to reciprocation of the idler support members with respect to the track frame ends to cushion recoil of the idlers,

a rotatable drive sprocket attachable to said axle housing and positioned between the ends of said track frame and above the idlers,

means driving the rotatable drive sprocket by the drive axle, and

a track chain emcompassing the idlers and drive sprocket and in driven engagement with the drive sprocket.

2. The combination of claim 1 wherein said idler support members comprise cranks having an intermediate point secured to the track frame ends and first and second legs diverging therefrom, said idlers being mounted on said first legs.

3. The combination of claim 2 further comprising,

bogies pivotally mounted on the second legs of the cranks, and

track rollers rotatably mounted on the bogies and engaging the track chain.

4. The combination of claim 1 further comprising,

bogies pivotally mounted on the track frame, and

track rollers rotatably mounted on the bogies.

5. The combination of claim 1 wherein said means pivotally and reciprocably securing the idler support members to the track frame ends comprises,

cylinder means provided on the track frame ends, and,

pistons slidable within the cylinder means,

and wherein the idler support members are pivotally mounted on the pistons.

6. The combination of claim 5 wherein said cushion means comprises,

second cylinders provided in the pistons, and

pilot pistons disposed in the second cylinders, the pilot pistons and second cylinders defining gas chambers, and the cylinders, pistons and pilot pistons defining fluid chambers, whereby the gas chambers and fluid chambers may be filled with fluids to cushion recoil of the idlers and to maintain the track chain at any desired tension.

7. The combination of claim 5 wherein said cushion means comprises,

an accumulator,

stub shafts disposed in said cylinders,

second cylinders formed in said pistons whereby the pistons are reciprocable within said cylinders and on said stub shafts, and

conduit means communicating the cylinders and the second cylinders formed in the pistons with the accumulator.

8. The combination of claim 1 wherein said means pivotally and slidably securing the idler support members to the track frame comprises,

slides secured to the track frame,

slide bearings slidable on the slides and pivotally mounting the idler support members,

cylinder means secured to the track frame,

piston means slidable within the cylinder means and in abutting engagement with the slide bearings, the cylinder means and piston means defining a fluid chamber,

an accumulator,

first and second parallel conduits communicating the fluid chamber with the accumulator,

a relief bleed valve in the first conduit, and

a check valve disposed in the second conduit, whereby upon restriction of the fluid chamber by movement of the piston means, the relief valve will open and fluid in the chamber will bleed into the accumulator, and upon subsequent expansion of the fluid chamber the check valve will open allowing fluid in the accumulator to return to the chamber.

9. The combination of claim 1 further comprising, housing means secured to the axle housing and extending upward therefrom, and wherein the drive sprocket is mounted on the housing means.

10. The combination of claim 1 further comprising resilient means responsive to pivoting of the cranks on the track frame.

11. The combination of claim 10 wherein the resilient means comprises spring means connecting the cranks and the main pivot shaft.

12. The combination of claim 10 wherein said resilient means comprises compression pads arranged for compression between the cranks and the track frame upon pivoting of the cranks.

13. The combination of claim 12 wherein said compression pads exhibit a progressive spring rate.

14. The combination of claim 13 wherein said compression pads comprise rubber blocks and wherein compression plates are provided on the track frame which progressively engage more and more of the block as it is moved toward the plates.

* * * * *

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United States Patent [19]

Dow et al.

[11] Patent Number: 5,373,909

[45] Date of Patent: Dec. 20, 1994

[54] **TRACKED VEHICLES AND POWER DRIVE APPARATUS FOR MOTIVATING TRACKED VEHICLES**

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[73] Assignee: **Byron Enterprises, Inc.**, Byron, N.Y.

[21] Appl. No.: **143,556**

[22] Filed: **Oct. 26, 1993**

[51] **Int. Cl.⁵** **B62D 55/00**

[52] **U.S. Cl.** **180/9.1**; 180/235; 305/21; 305/28

[58] **Field of Search** .... 180/9.1, 9.42, 9.44, 180/9.62, 235; 305/21, 22, 24, 28, 35 R, 35 EB

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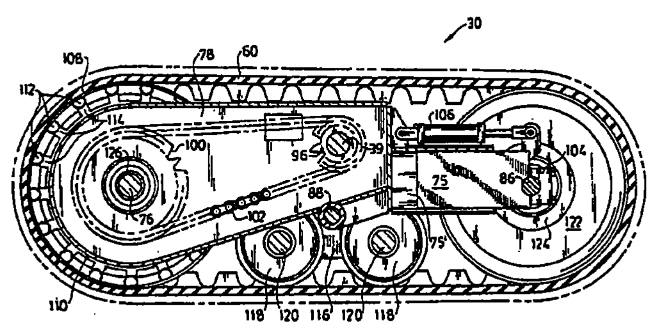
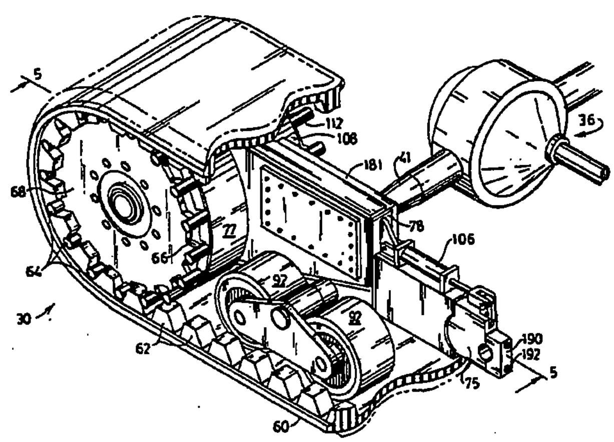
Primary Examiner—Eric D. Culbreth
Assistant Examiner—Victor E. Johnson
Attorney, Agent, or Firm—M. Lukacher

[57] **ABSTRACT**

An articulated tracked vehicle for agricultural harvesting which reduces damage to fields and can be driven on paved roads at reasonable speeds. The vehicle has front and rear elements, linked by an articulating joint which permits turning and rotation of one element with respect to the other. Each element is motivated by a pair of tracked power units which are hydraulically driven by a heavy duty differential between the units. Each power unit is rotatably mounted solely on a shaft sleeve of the differential and is free to oscillate vertically and independently to absorb irregularities in its path. Each unit includes an endless elastomeric track which has two rows of lugs on its inner surface. A novel drive mechanism engages these lugs to motivate the vehicle. A sealed transmission housing in each power unit protects key drive elements from environmental damage without interfering with operation of the unit. The transmission is centrally disposed within each power unit to provide further protection from damage.

9 Claims, 13 Drawing Sheets





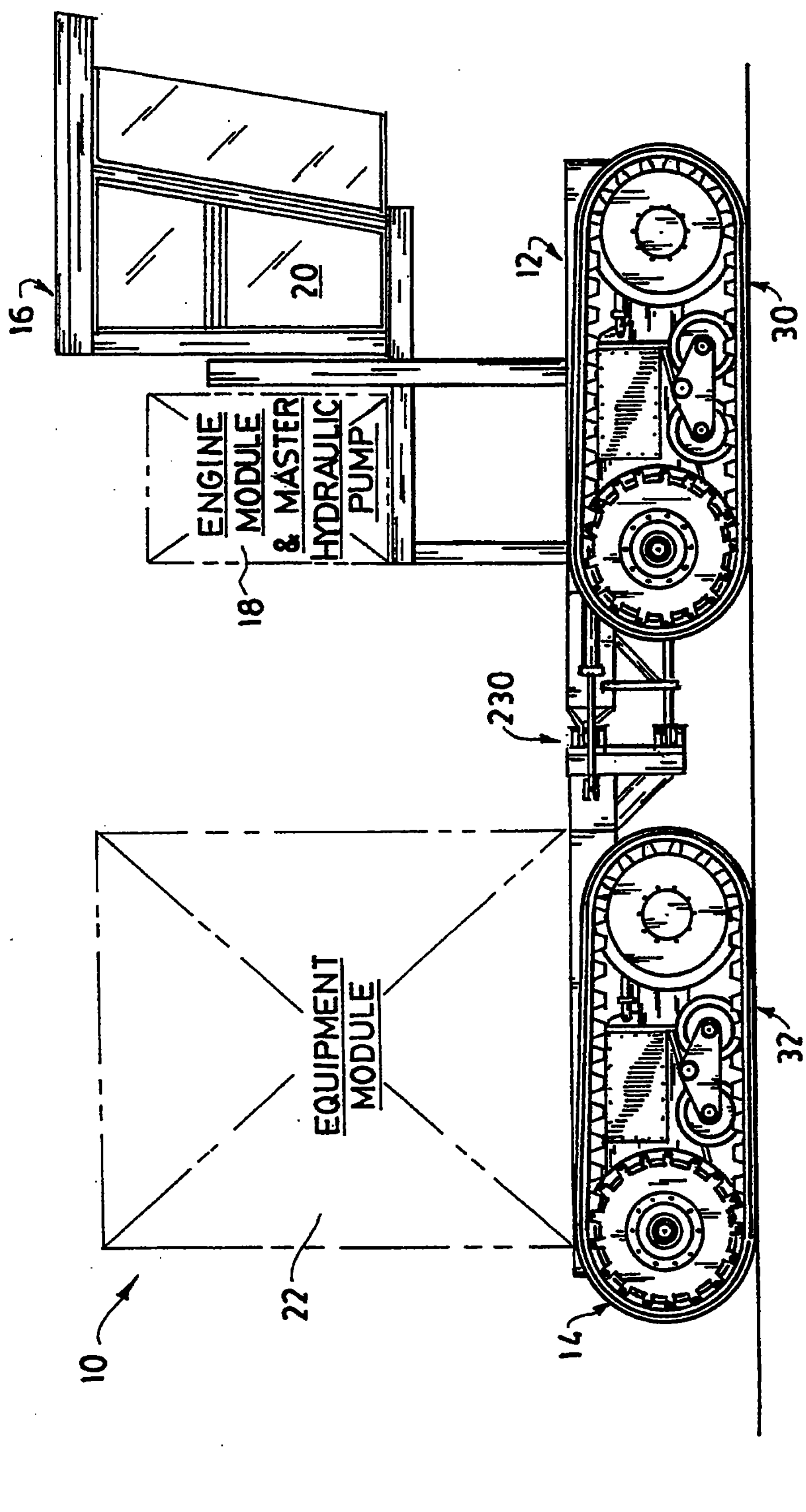

16
20
12
30
ENGINE MODULE & MASTER HYDRAULIC PUMP
18
230
EQUIPMENT MODULE
32
10
22
14

FIG. 1

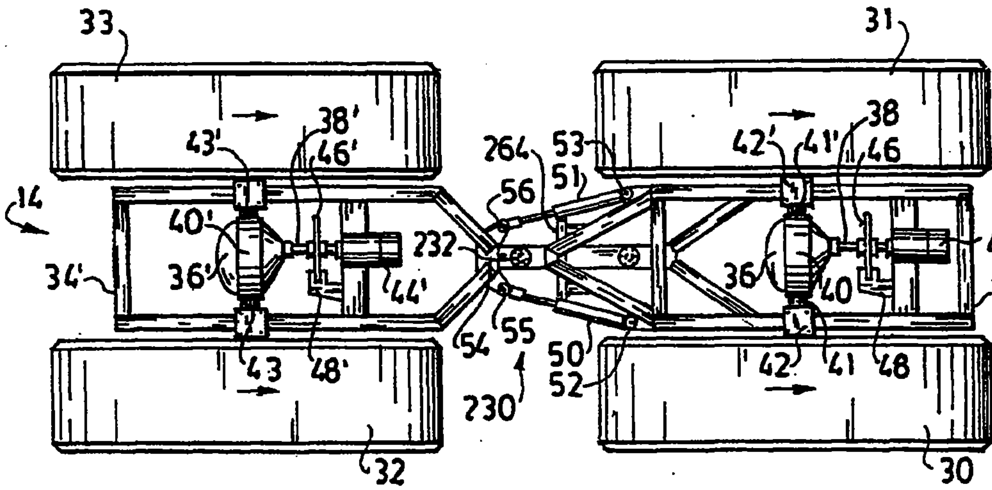

33
31
43'
38'
46'
264
53
42'
41'
38
46
14
56
51
12
40'
232
44
34'
36'
44'
36
40
34
54
55
50
42
41
48
43
48'
52
230
32
30

FIG. 2

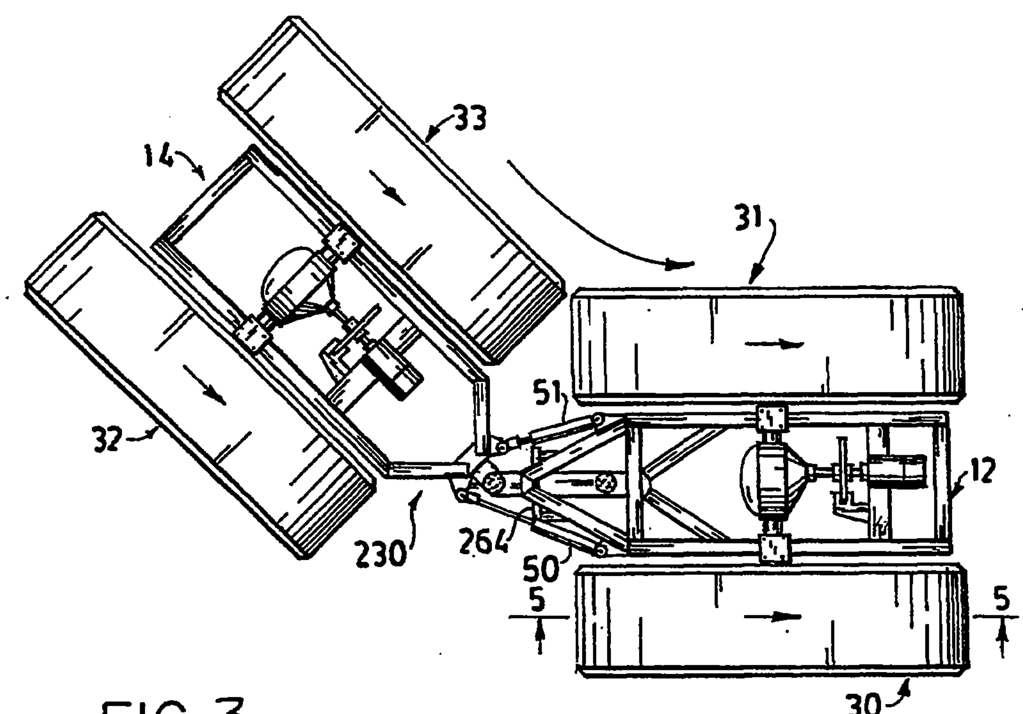

33
14
31
51
32
12
230
264
50
5
5
30

FIG. 3

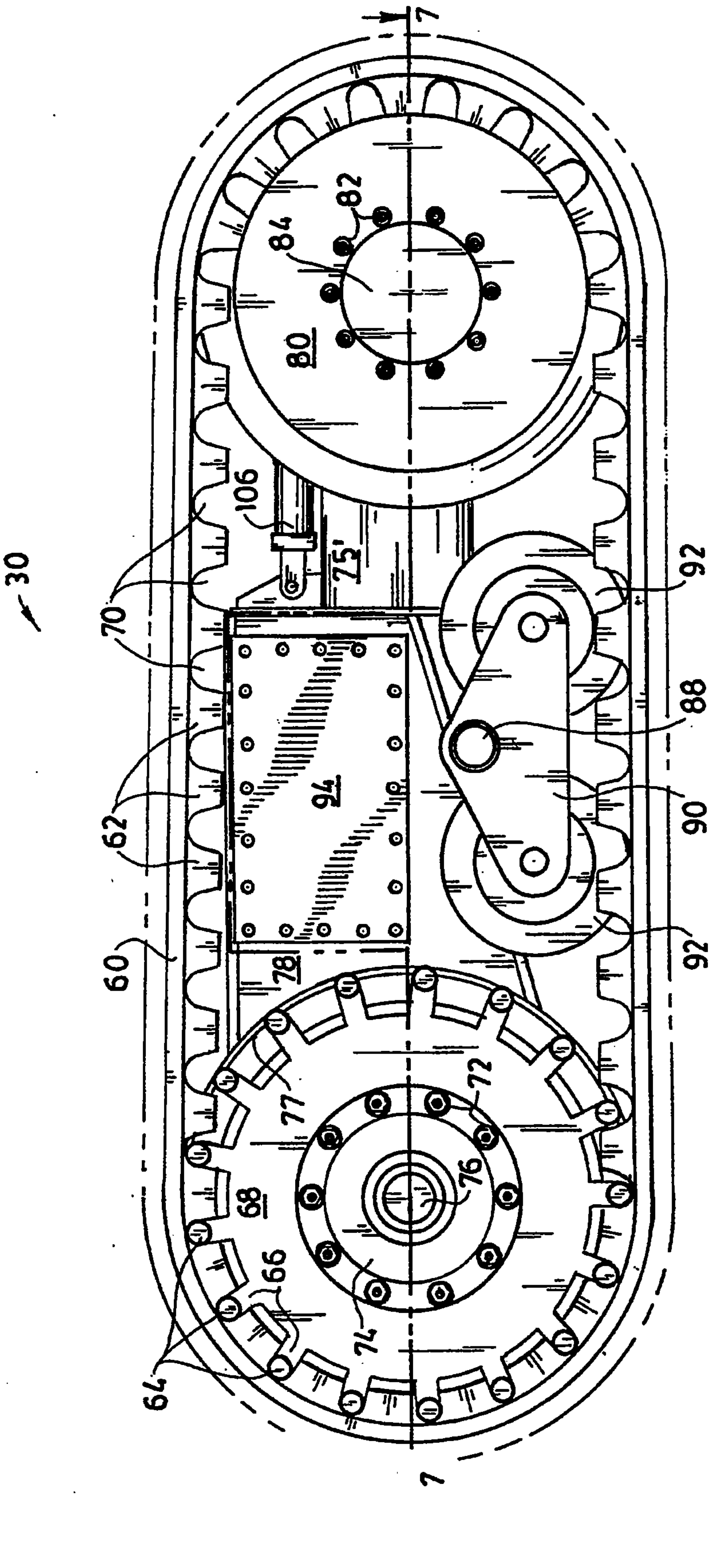


FIG. 4

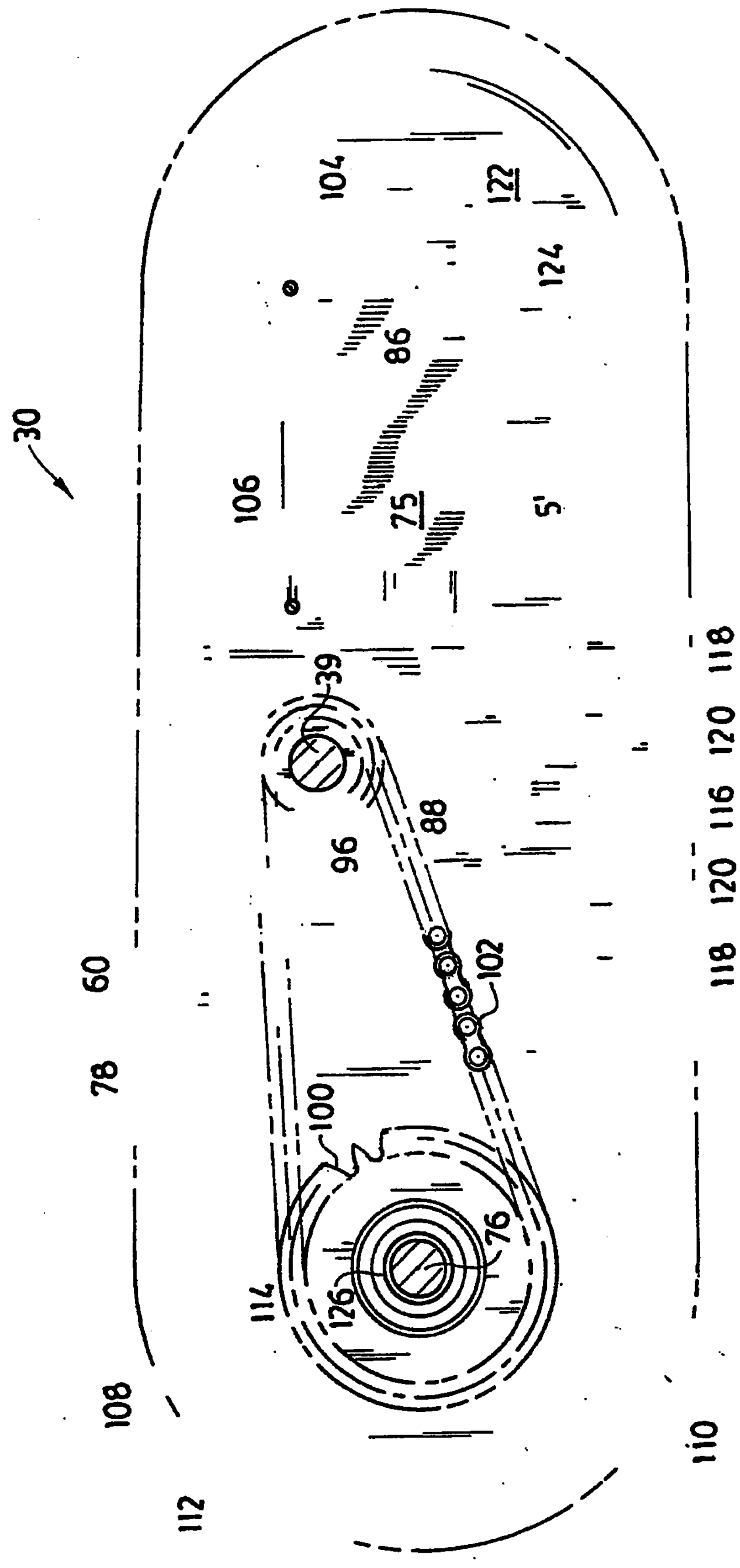

30
104
122
124
86
106
75
51
39
88
96
118
120
116
120
118
102
60
78
100
76
126
114
108
110
112

FIG. 5

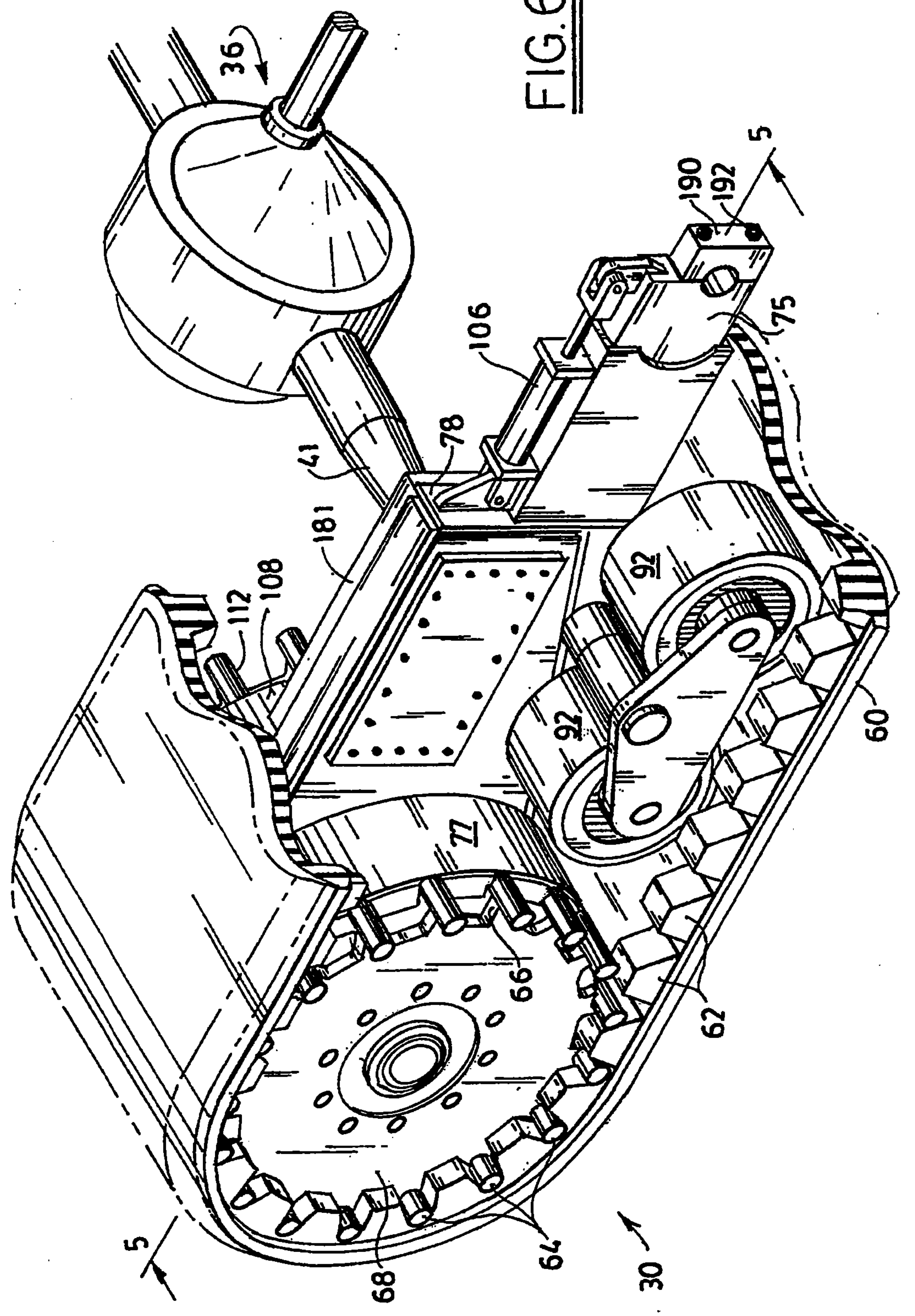


FIG.6

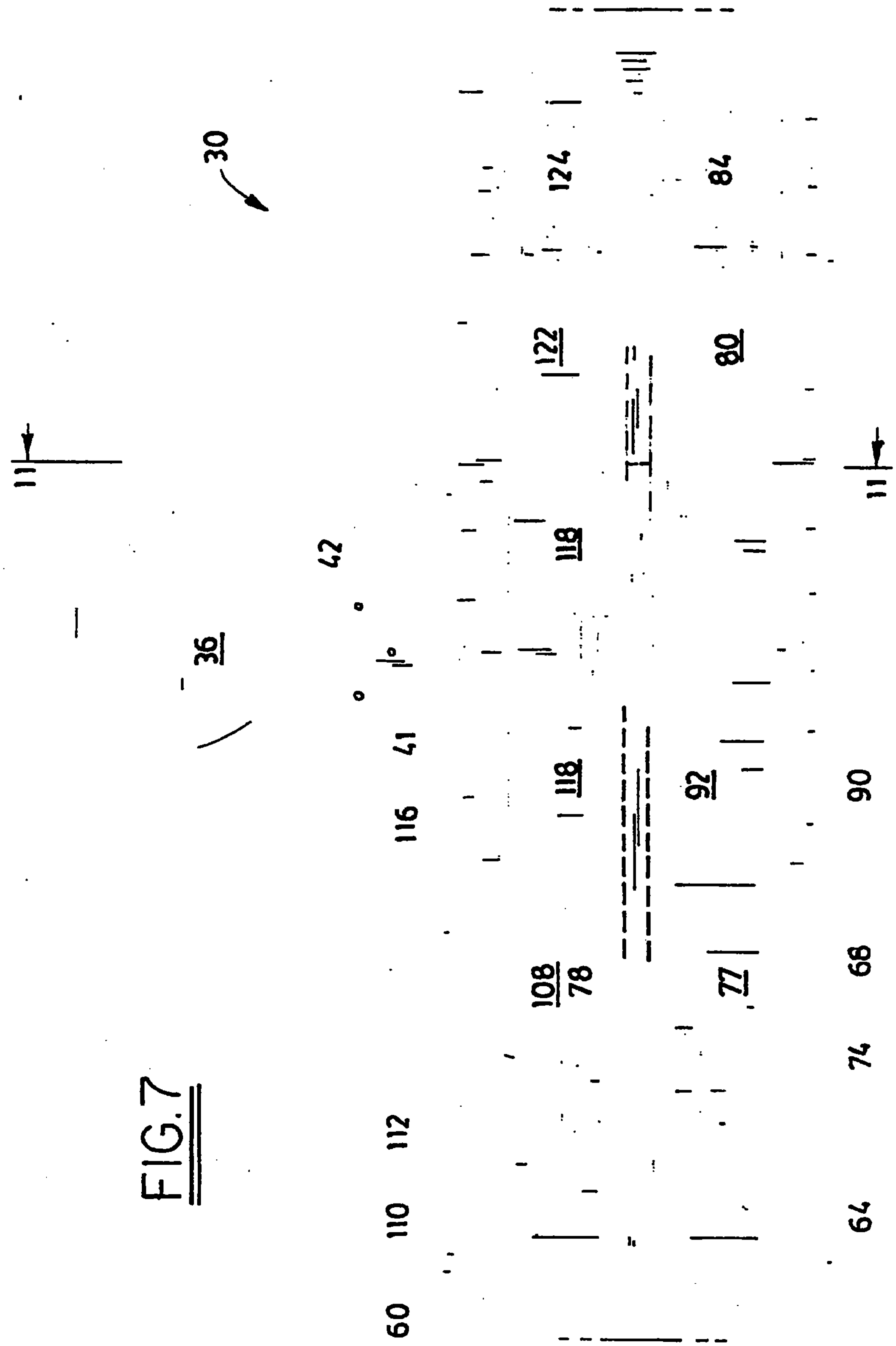
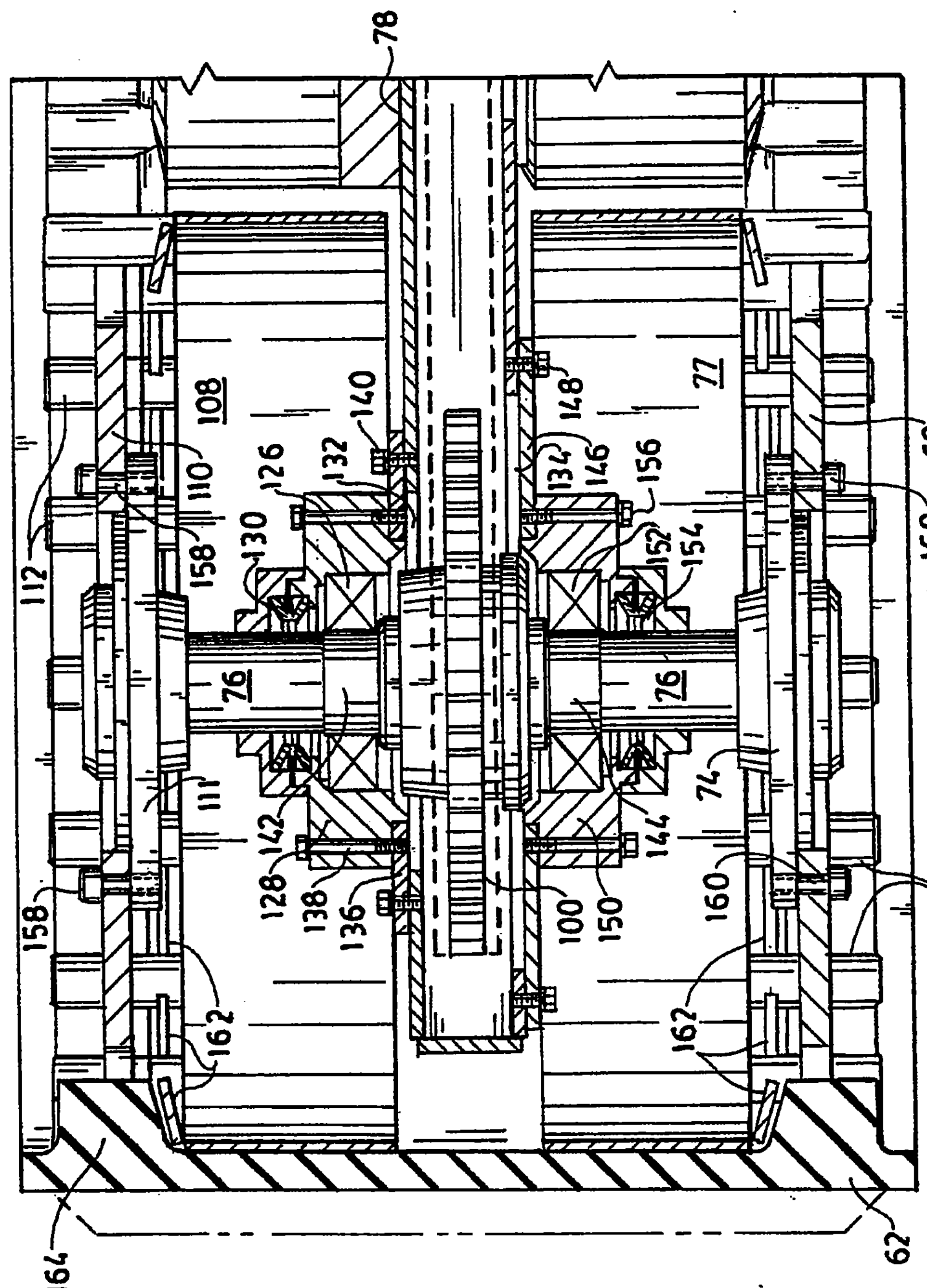

30
124
84
122
80
11
11
42
118
36
41
118
116
92
90
108
78
77
68
74
112
110
64
60

FIG. 7


78
108
140
148
77
68
110
126
132
134
146
156
112
158
130
152
154
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76
76
76
30
74
111
142
144
128
138
136
100
150
158
160
64
162
162
162
164
62

FIG.8

FIG.9

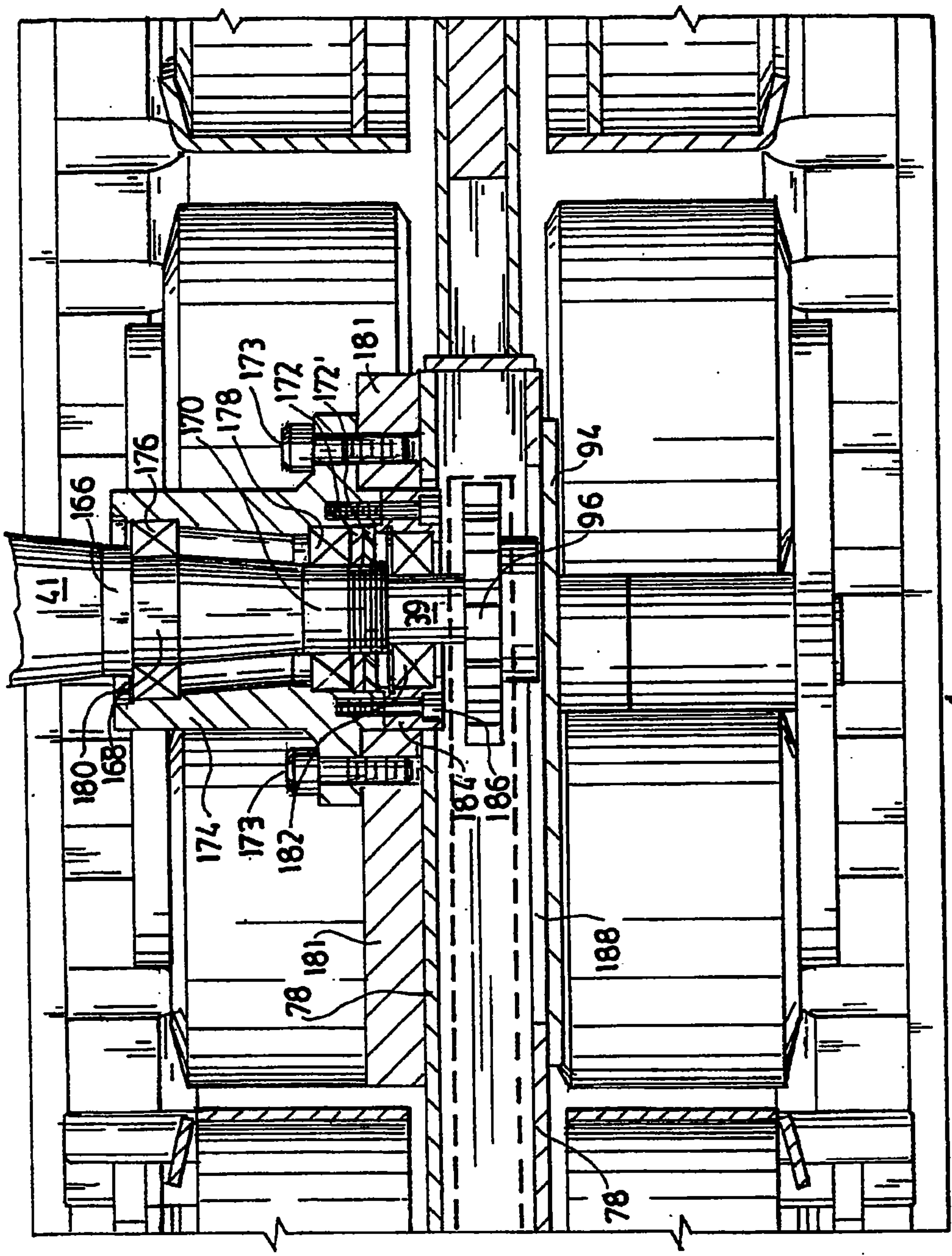
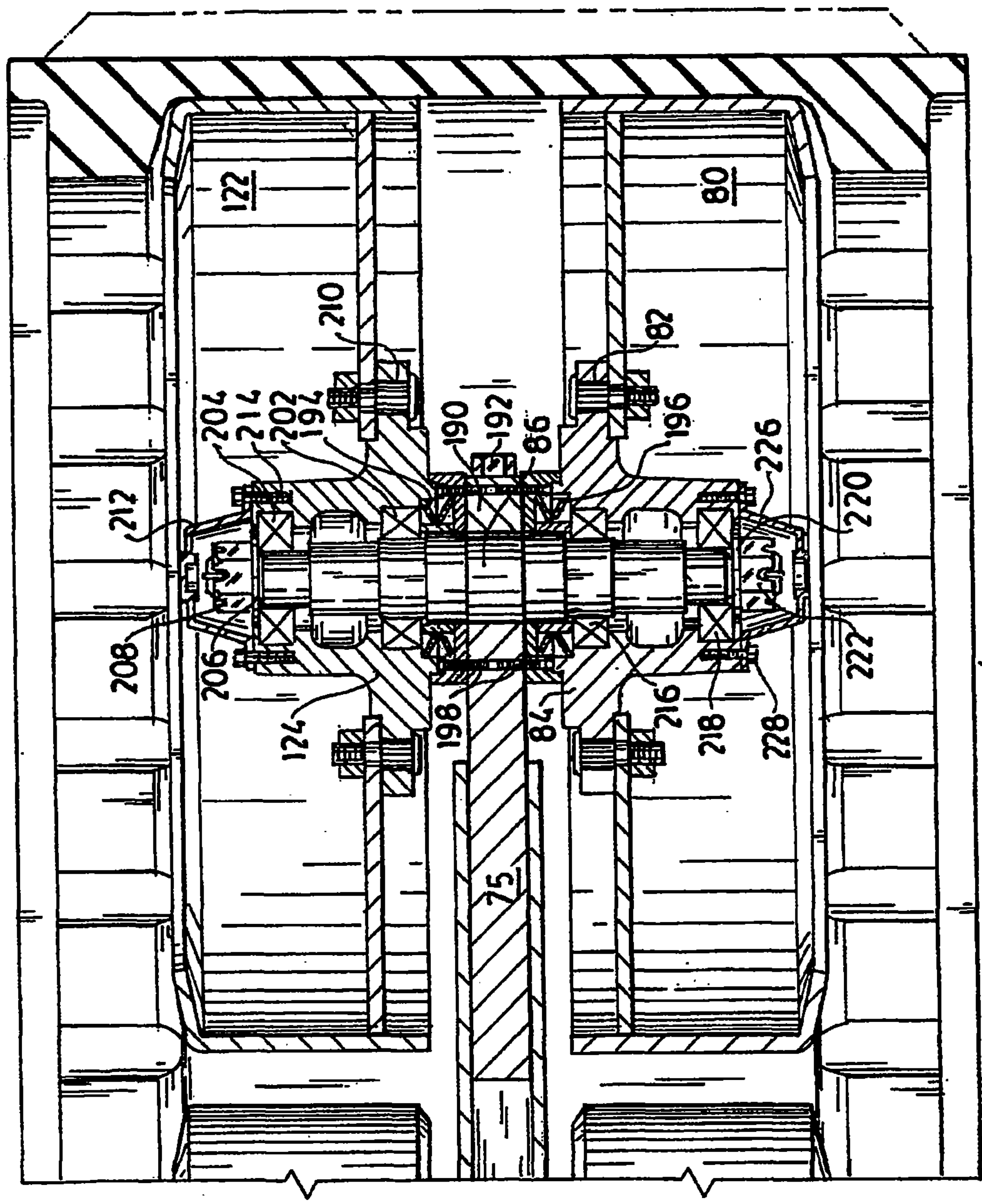

166
176
170
178
173
172
172'
181
94
96
41
39
180
168
174
173
182
184
186
188
181
78
78
30

FIG.10


122
80
210
82
204
214
202
194
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86
196
226
212
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208
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124
198
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218
228
222
75
30

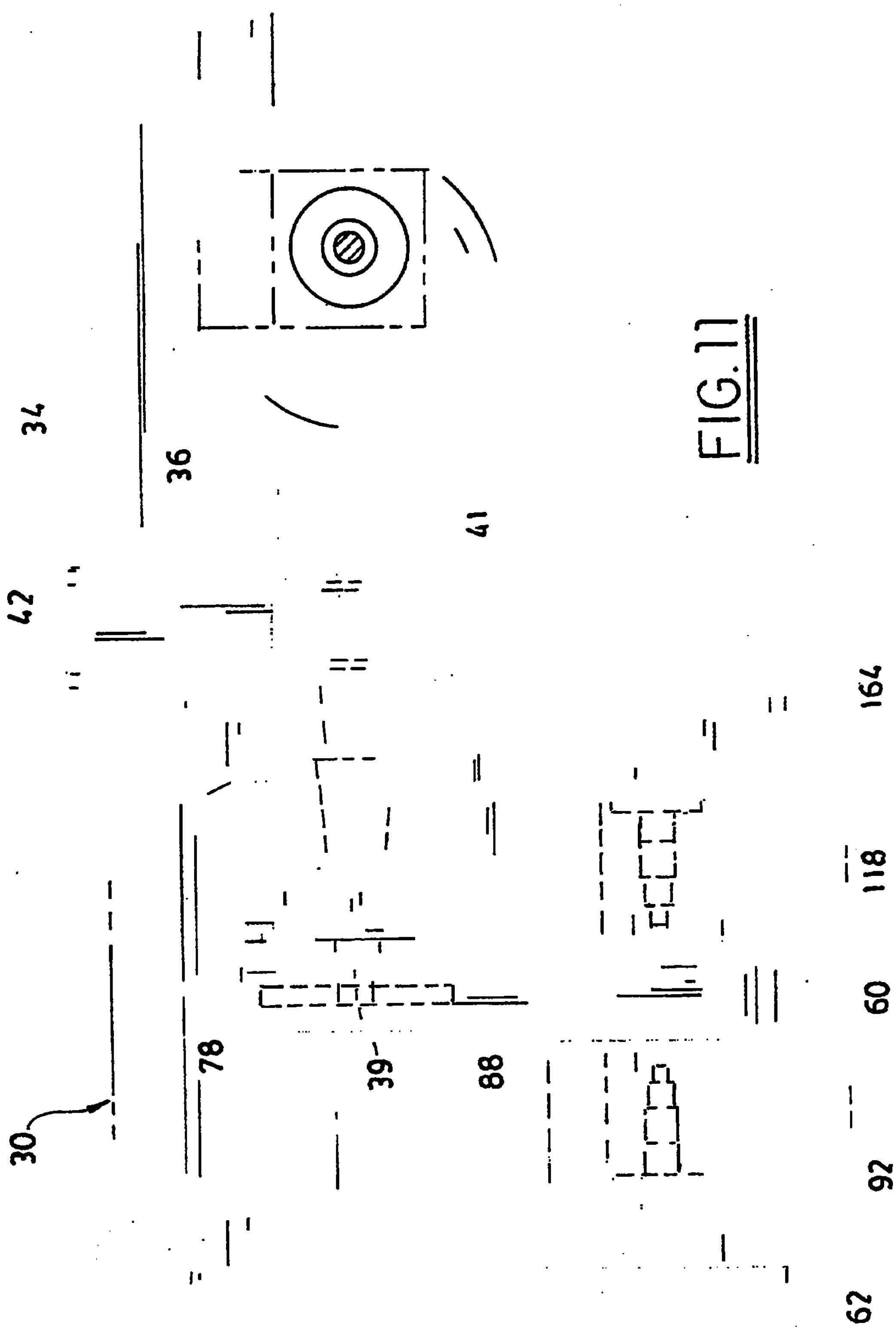

FIG. 11

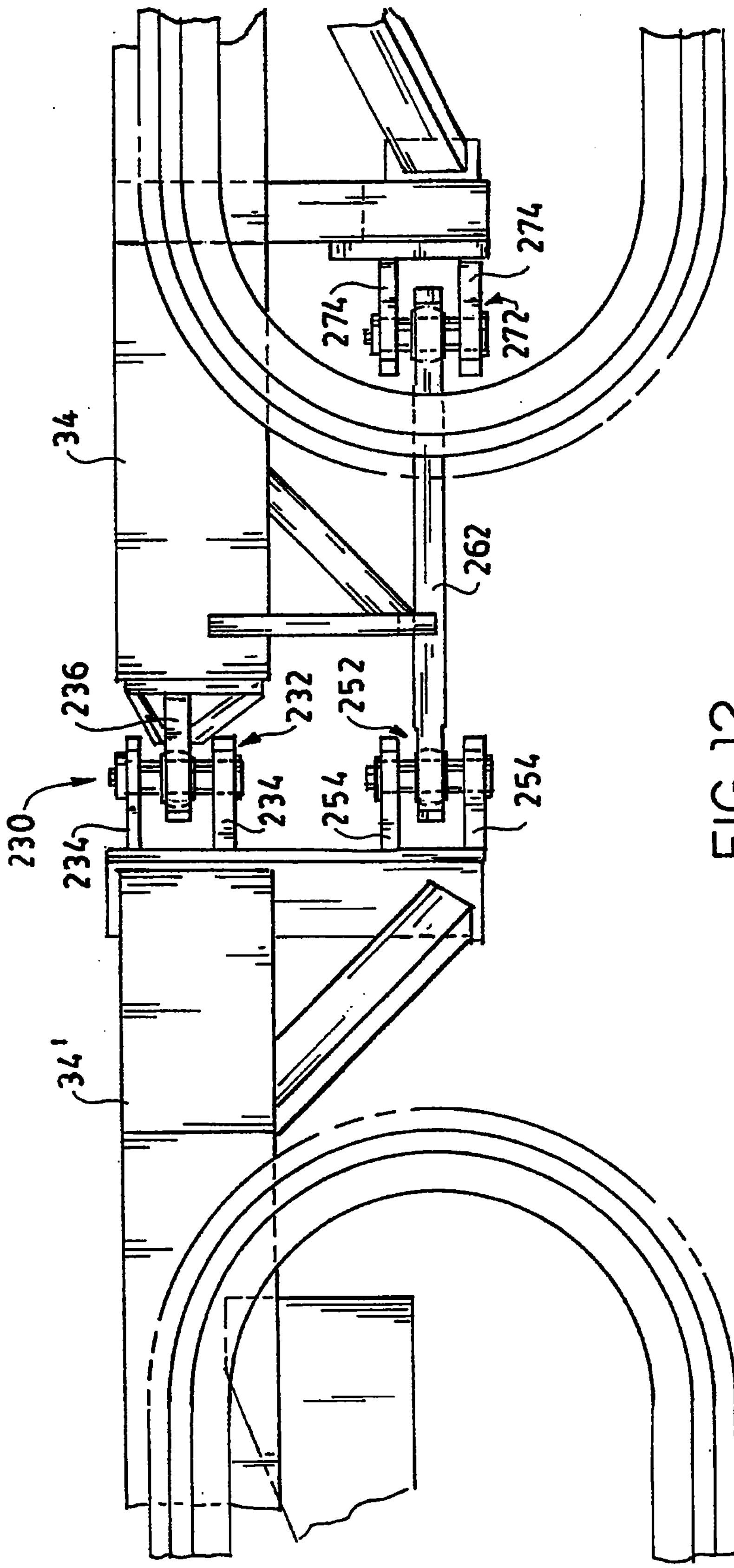

FIG. 12

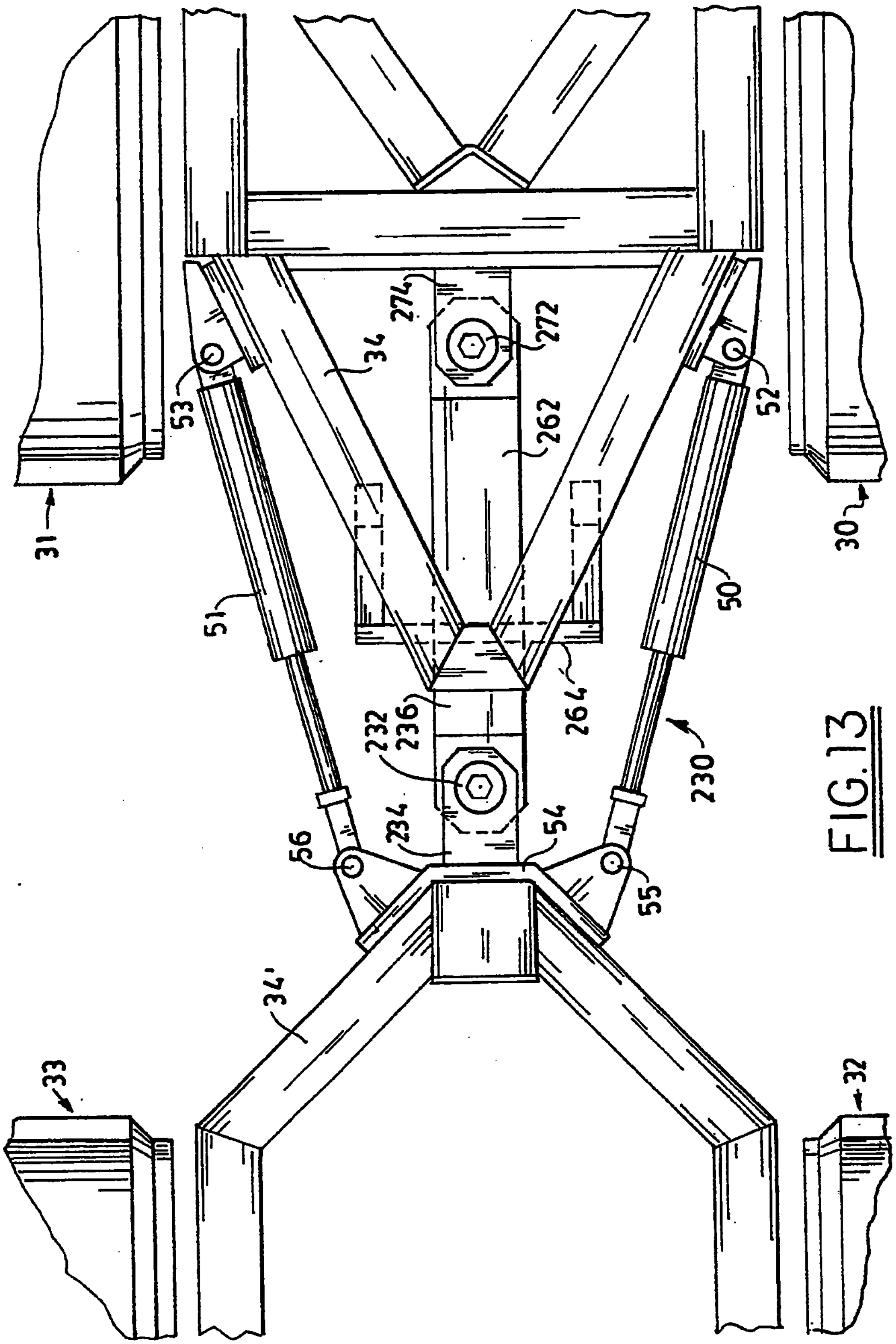
274
272
34
53
262
52
31
30
51
50
264
236
232
230
56
234
54
55
34'
33
32

FIG. 13

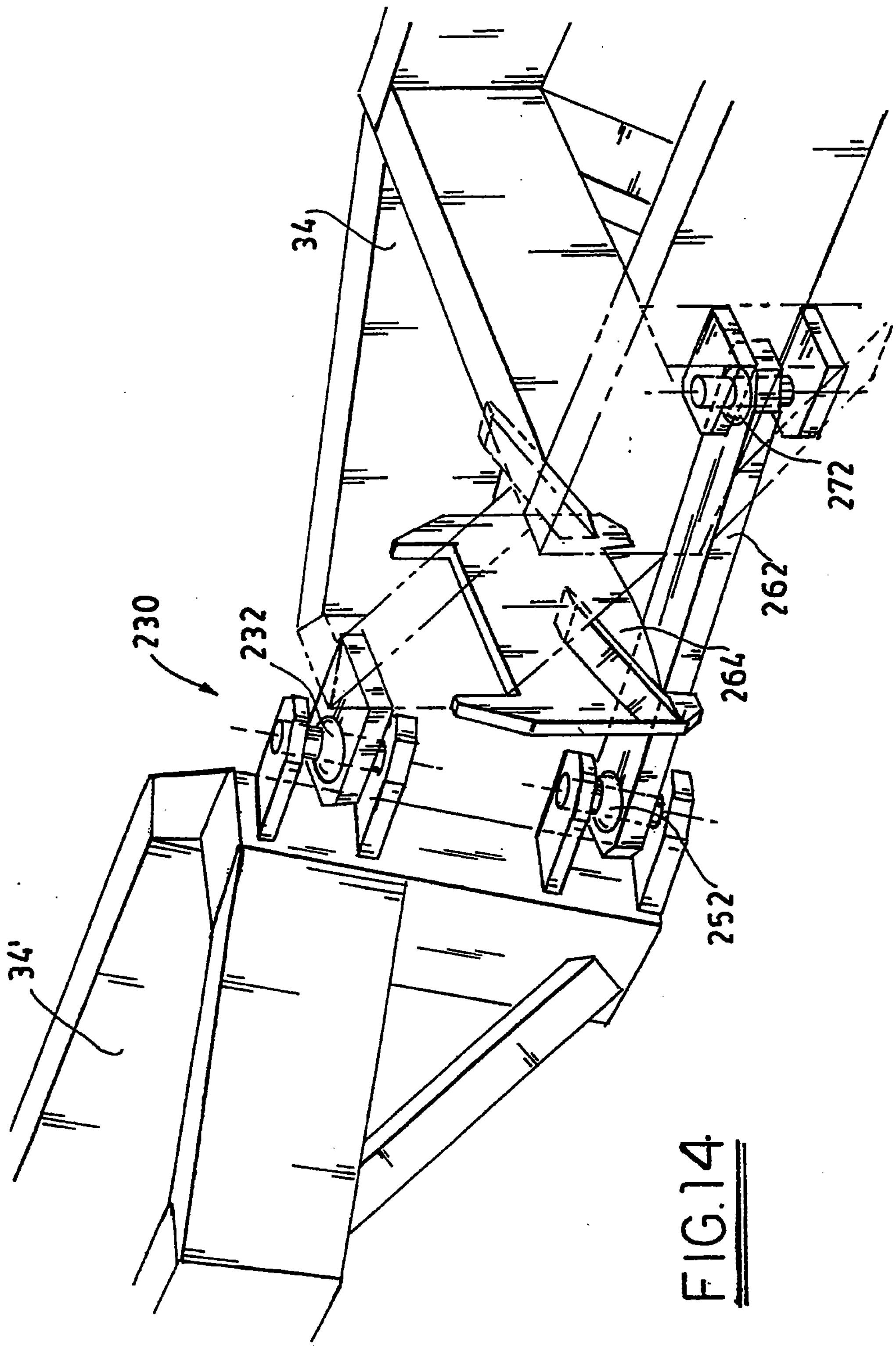

FIG. 14

TRACKED VEHICLES AND POWER DRIVE APPARATUS FOR MOTIVATING TRACKED VEHICLES

FIELD OF THE INVENTION

The invention relates to tracked vehicles, and more particularly to power drive apparatus for tracked vehicles, which may have front and rear driven sections with an articulated connection for coupling and steering the vehicles, and which may be hydraulically powered. The present invention is especially useful in providing power units for supporting or motivating agricultural harvesting apparatus such as heads and threshers which pick the crop. Power units have sometimes been called tractors.

BACKGROUND OF THE INVENTION

Off-road vehicles are commonly equipped with endless tracks rather than tires. Tracks have been found to be more useful than tires in rough or marshy terrain, in that they are less prone to stress-induced failures and to becoming bogged down. Tracks are desirable because they spread their load (several thousand pounds for large agricultural power drives) over a larger surface area than do tires for similar loads, so that the tracked vehicles do not sink into the ground. For this reason, tracked power drive vehicles have become widespread in off-road applications such as construction, the military, recreational vehicles, snow grooming, and some tracked vehicles have been used in agricultural harvesting. See, for example, U.S. Pat. No. 5,176,573 issued to Paul Dow on Jan. 5, 1993.

Tracked vehicles commonly employ endless linked steel belts as tracks. These steel tracks are usually cleated on the outside to improve traction. Steering is commonly accomplished by immobilizing one of the tracks and driving the other, causing the vehicle to pivot on its stationary track. This maneuver requires high horsepower and also does significant damage to the surface beneath the vehicle. Therefore, steel-tracked vehicles are generally prohibited on paved roadways and must be transported over the road on flatbed trucks.

Agricultural harvesters are used in plowed fields and even during wet weather; then, tracks are superior to tires for traction. An added advantage of tracks is that they do less damage to the soil by way of compaction and rutting. Recently, tracks made of elastomeric materials such as rubber or plastic have become available as alternatives to steel tracks. In agricultural harvesting, for example, rubber tracked vehicles can be driven in the fields without significant damage to the soil and then be driven over paved roads from field to field. It is a feature of the invention to provide improved tracked vehicles which can travel over the road, and at reasonable speeds.

Tracked vehicles are known to be powered hydraulically, as disclosed in, for example, U.S. Pat. No. 3,447,619. A common drive utilizes a low-speed high-torque (LSHT) hydraulic motor. Such drives are powerful but are incapable of road speeds above about 15 miles per hour, whereas many portions of the harvesting industry depend upon a road speed of 20 miles per hour or higher to meet the demands of the harvesting schedule. Other drives use high-speed hydraulic motors with gear reduction, but these are bulky, costly, and subject to high maintenance.

A common means of driving a rubber track is by forming a drive wheel within the power unit as essentially a sprocket and engaging the teeth of the sprocket with holes formed in the track. This design has the drawback that the sprocket teeth protrude through the rubber track and can dig up the field and, more seriously, do damage to paved roadway.

Off-road tracked vehicles must handle rough, rocky terrain without conventional ride-softening suspension elements such as springs and shock-absorbers, which would interfere with precise location of the picking and threshing mechanisms with respect to the crop and with respect to each other. Track designs which have heretofore been proposed include designs which ride very roughly over objects in their path. The track assembly must ride up on the object, reach its balance point, and then fall forward, with no means within the action of the track to absorb the shock of encountering the obstacle.

A drawback of conventional two-track vehicles resides in the long length of track required to support the vehicle. This exacerbates the aforementioned steering difficulty and surface damage. While four-track vehicles having a two-part articulated chassis have been proposed, for example, in U.S. Pat. Nos. 3,435,908; 3,741,331; 3,789,942; 3,937,289; and 4,072,203, they have not been suitable for heavy loads as required for agricultural harvesting applications. It is a feature of the invention to provide improved power drives which enable four-track vehicles to haul heavy loads over rough terrain and with positional stability needed to locate harvesting heads and threshing components with respect to the ground and to each other.

An additional drawback of conventional four-track vehicles is the need to limit the freedom of articulation of the joint between front and rear elements to left and right horizontally. This limits the ability of the vehicle to adapt to irregular terrain. This is because vertical rigidity must be maintained between the two elements, particularly in designs in which independent vertical oscillation of each of the four power units is permitted. Without vertical rigidity, the articulating joint is vertically unstable in such conventional two-track vehicles. For this reason, a simple ball-joint connection cannot be used. It is a feature of the invention to provide a joint for an articulated tracked vehicle which permits both horizontal (left and right) and rotational (about a longitudinal axis through the rear element) relative motion of the front and rear elements, while maintaining vertical rigidity between the elements.

Track drive units commonly are designed with rugged drive elements such as sprockets and chains which are exposed for easy repair and maintenance, which has the drawback of making these elements vulnerable to damage. It is a feature of this invention to provide a power unit for a tracked vehicle wherein the drive elements are encased and located, within the unit for maximum protection of the elements, but in a way which does not interfere with operation and which still permits ready access for repairs and maintenance.

SUMMARY OF THE INVENTION

The invention provides an improved hydraulically powered tracked power unit adapted for use on a tracked vehicle, and preferably on an articulated tracked vehicle. An articulated tracked vehicle in ac-

cordance with the invention may have two pairs of such power units.

More particularly, a power unit, which is provided in accordance with an embodiment of the invention, is driven by a chain-drive transmission, housed in a rugged, rigid sealed housing, which is also the primary structural element of the power unit. The housing is rotatably mounted on a fixed sleeve of a differential on the vehicle, allowing the power unit to pivot vertically about a horizontal axis in response to encountering an object in its path. This response, which is analogous to the spring and shock absorber action in a wheeled vehicle, minimizes the vertical displacement of the axis. The transmission drives a member which comprises both a road wheel and track drive sprocket, which sprocket engages lugs formed on the inner surface of an endless track and motivates the track thereby transmitting motive power to the ground beneath the power unit.

Preferably, the chain drive transmission and its housing are located along the longitudinal centerline of the power unit to remove them as far as possible from hazards to either the left or right of the track.

The power unit may further comprise idler road wheels also within the track; a pair of oscillating idler bogies to aid in absorbing protrusions above the surface of the road; and a device to maintain proper tension in the endless track.

An articulated tracked vehicle of the invention has a front and a rear chassis, connected by an articulating joint and adapted to be steered by means of functionally-opposed hydraulic cylinders to the left and right of the articulating joint, whereby the front chassis can be turned either left or right with respect to the rear chassis. Additionally, in a preferred embodiment, the articulating joint comprises three spherical bearings and a rotating link, the arrangement of which also permits longitudinal relative rotation of the front chassis with respect to the rear chassis while maintaining vertical rigidity of the joint.

Each chassis further comprises a rigidly-mounted hydraulically-powered differential unit having a rugged, sealed housing comparable in strength to that of the power unit transmission housing. Two power units are each rotatably disposed on the shaft sleeves of the two output power shafts of the differential which extend in opposite directions from the differential. The two power units are thereby free to oscillate vertically with respect to the chassis and to each other. The articulated vehicle, comprising two chassis and four independent power units, can operate over very rough terrain with extreme stability and minimum vertical selective displacement.

The vehicle may be powered by an engine mounted on one of the chassis. An equipment module which may include harvesting or threshing devices can be carried by the other chassis. The engine drives a master hydraulic pump system, which in turn powers two independent hydraulic drive elements, disc brakes for the front and rear differential units, and the hydraulic steering cylinders.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side elevation of an articulated tracked vehicle according to the invention, where the equipment and motors are shown schematically.

FIG. 2 is a top view of the vehicle of FIG. 1 with the superstructure removed.

FIG. 3 is a top view like FIG. 2 with the vehicle of FIG. 2 in a turning mode.

FIG. 4 is an enlarged side elevation of one of the typical tracked power units of the vehicle of FIG. 1.

FIG. 5 is a sectional view taken along line 5—5 in FIG. 3 and FIG. 6, approximately middleway of the width of the track.

FIG. 6 is a fragmentary perspective view, partially in section, of the power unit shown in FIGS. 4 and 5.

FIG. 7 is a sectional view taken along line 7—7 in FIG. 4.

FIG. 8 is a view like FIG. 7, enlarged to show the rear of the unit, including the driven sprocket and drive wheels, in greater detail than in FIG. 7.

FIG. 9 is a view like FIG. 7, enlarged to show in greater detail the middle portion of the unit of FIG. 7, including the drive sprocket and mount on which the unit can rotate.

FIG. 10 is a view like FIG. 7, enlarged to show the front of the unit, including the arrangement of idler wheels, in greater detail than in FIG. 7.

FIG. 11 is a sectional view taken along line 11—11 in FIG. 7.

FIG. 12 is an enlarged side elevation of the central area of FIG. 1, showing details of the articulating joint.

FIG. 13 is an enlarged view of the central area of FIG. 2, showing details of the articulating joint.

FIG. 14 is an isometric view of the articulating joint of FIGS. 12 and 13, showing the joint in articulation and the limitation of rotation of one chassis with respect to the other imposed by the rotation limiting plate.

DETAILED DESCRIPTION OF THE INVENTION

Referring to the figures, wherein like numbers are given to like elements in the different drawings, in FIG. 1 is shown an articulated tracked vehicle 10 in accordance with the invention. The vehicle has a front driven element 12 and a rear driven element 14 which are substantially identical mechanically. Front element 12 carries a superstructure 16 comprising an engine module 18 which includes a master hydraulic pump, both shown schematically, and which powers both elements 12 and 14 of vehicle 10. Superstructure 16 also includes an operator compartment 20 for control of the driving functions of the vehicle and the equipment functions of the equipment module 22 carried by rear element 14. Alternatively, superstructure 16 can be sized or positioned on front element 12 such that some elements of equipment module 22 can be borne by front element 12. Front element 12 and rear element 14 can be the same or different in length, width, and height.

In a preferred embodiment, front and rear elements 12 and 14 are coupled by an articulating joint 230, as shown variously in FIGS. 1, 2, 3, 12, 13 and 14. Shown are three substantially identical spherical bearing units: upper 232, lower rear 252, and lower forward 272. These three bearing units are coplanar in a vertical plane containing the longitudinal axis of vehicle 10 when vehicle 10 is on level ground. Commercially-available bearing units, such as Torrington 22 SF-36 Spherical Bearings, available from The Torrington Co., Torrington, Conn., are suitable for this purpose.

Bearing unit 232 is mounted in the flanges of upper bearing mount 234 on rear chassis 34′. Bearing unit 252 is mounted in the flanges of rear chassis lower bearing mount 254 directly below and co-linear with bearing unit 232. The race of bearing unit 232 is connected to

front chassis 34 by bearing mount 236. Bearing 272 is mounted on front chassis 34 in the flanges of lower forward bearing mount 274, directly forward of bearing unit 252. The races of bearing unit 252 and 272 are connected by rotatable link 262, said link thereby being allowed to rotate about its longitudinal axis in response to rotation of front element 12 relative to rear element 14.

In operation, bearings 232 and 252 constitute a vertical hinge, allowing front element 12 to turn left or right relative to rear element 14 as shown in FIG. 3. Additionally, the three spherical bearings 232, 252, 272, and rotatable link 262 cooperate to allow longitudinal rotation of front element 12 relative to rear element 14 while maintaining vertical rigidity of articulating joint 230. The longitudinal axis of the vehicle can bend only left or right, never up or down. Rotation of link 262 is limited by rotation limiting plate 264 to 15° from horizontal, either clockwise or counterclockwise.

FIG. 14 shows the relationship of rotatable link 262 to rotation limiting plate 264. This limitation is necessary to prevent damage to bearings 232, 252 and 272.

Alternatively, front and rear elements 12 and 14 can be coupled by mounting a vertical hinge (not shown) in place of bearings 232 and 252, and by eliminating bearing 272 and fixedly connecting link 262 to front chassis 34. This hinge arrangement provides full freedom of motion laterally for steering and is rigid vertically, but does not permit rotation of one chassis element with respect to the other.

Also shown in FIG. 1 are right side front and rear tracked power units 30 and 32, respectively, the construction and operation of which is described herebelow.

FIG. 2 is a top view of the vehicle in FIG. 1 with the superstructure removed for clarity of presentation, showing the close similarity in design between the front and rear driven elements 12 and 14. FIG. 2 shows the general layout of the vehicle comprising front right and left tracked power units 30 and 31 on front element 12, and rear right and left power units 32 and 33 on rear element 14.

Front element 12 includes a structural chassis 34. Front differential 36 is a conventional, heavy duty differential having a power input shaft 38 and two diametrically opposed power output shafts 39 and 39' (not visible in FIG. 2). The housing 40 of differential 36 is strong enough to withstand the torsional loads exerted on it by the attachment and action of the power units as is described herebelow.

Power output shafts 39 and 39' are carried in fixed sleeves 41 and 41', respectively, which are integral with differential housing 40 and are rigidly attached to the underside of chassis 34 by clamps 42 and 42', respectively.

Power input shaft 38 is connected to a variable displacement hydraulic motor 44 which is rigidly mounted on chassis 34 and is supplied with high-pressure hydraulic fluid from the master hydraulic pump (means not shown). Fixed on power input shaft 38 is disc 46 which cooperates with chassis-mounted caliper 48 as a disc braking system for front element 12. Caliper 48 is also hydraulically supplied by the master hydraulic pump. Braking is accomplished by de-powering of the differential hydraulic drive motor and/or pressurizing of the hydraulic brake caliper.

The design and operation of rear driven element 14 is virtually identical with that of front element 12. The analogous parts are rear structural chassis 34'; rear differential 36'; rear differential power input shaft 38'; rear differential housing 40'; rear differential fixed sleeves 43 and 43'; rear variable displacement hydraulic motor 44'; rear brake disc 46'; and rear brake caliper 48'.

FIGS. 2 and 13 also show the layout of the steering mechanism. Right and left double-action hydraulic steering cylinders 50 and 51 are connected at their forward ends to front chassis 34 on opposite sides of articulating joint 230 by ball joints 52 and 53, respectively, and at their rear ends to yoke 54 by ball joints 55 and 56, respectively. Yoke 54 is a rigid member on rear chassis 34'.

The vehicle is turned, or steered, as is shown in FIG. 3. Right steering cylinder 50 is extended while left steering cylinder 51 is simultaneously retracted, causing front element 12 to turn to the left with respect to rear element 14. Rear element 14 will follow front element 12 on nearly the same track. The front and rear differentials permit the right side power units 30 and 32 to turn faster than the left side power units 31 and 33, thereby turning the vehicle in an arc to the left with minimal added horsepower required and with minimal scrubbing and damage to the surface under the tracks. Turning to the right is accomplished by reversing the actions of steering cylinders 50 and 51. Ball joints 52, 53, 55 and 56 are designed and placed such that even at maximum stroke of the cylinders there is no interference between the tracks of the power units on the front and rear chassis.

FIG. 4 is an enlarged side elevation of right side tracked power unit 30 of vehicle 10. A sealed structural housing 78 is shown which protects drive elements within it as well as being the principal structural member of power unit 30. Rotating axle 76, connected to the drive within housing 78, protrudes through both sides of housing 78. A telescoping structural member 75 (not visible in FIG. 4) is disposed in a fixed member 75' on the forward end of housing 78 to carry an idler fixed axle 86 (not visible in FIG. 4.) A bogie fixed axle 88 is disposed on the underside of structural housing 78. Outer track drive sprocket 68 is affixed by nuts and bolts 72 to a stepped hub 74 mounted on rotating axle 76. Endless track 60 is shown with outboard drive lugs 62 affixed to its inner surface and engaging with outer drive bars 64 affixed to the tips of spaced teeth 66 of track drive sprocket 68 near the rear end of power unit 30. Lugs 62 have rounded valleys 70 between them, such that the valleys fit snugly around bars 64 and the lugs fit snugly between spaced teeth 66 when the track is travelling around drive sprocket 68. Bars 64 are also further affixed laterally to a smooth outer drive wheel 77 which is sized to fit snugly against the inner surface of endless track 60 inboard of lugs 62.

FIG. 4 also shows outer idler wheel 80 near the front end of power unit 30. Outer idler wheel 80 is affixed by bolts 82 to outer hub 84 which rotates on idler fixed axle 86 (not visible in FIG. 4). Outer idler wheel 80 is bevelled around its circumference and is sized to fit snugly against the inner surface of endless track 60 inboard of outboard drive lugs 62. The arrangement of idler wheels is shown in more detail in FIGS. 7 and 10.

An outer bogie, comprising a swing arm 90 carrying two outer bogie wheels 92, is mounted on bogie fixed axle 88. Outer bogie wheels 92 are aligned longitudinally with outer drive wheel 77 and with outer idler wheel 80. Swing arm 90 is free to oscillate about fixed axle 88 in response to protrusions in the road under the

track, thereby providing firm yet resilient support for track 60. This greatly reduces the undesirable characteristic of formerly-proposed track designs which force the entire vehicle to ride unforgivingly up and over such protrusions. The arrangement of the bogie is shown in greater detail in FIGS. 6, 7 and 9.

FIG. 4 also shows an access panel 94 on the outside of housing 78 whereby drive components within housing 78 are easily reached for assembly, repair, or maintenance.

FIG. 4 also shows part of the mechanism for maintaining tension in endless track 60, including hydraulic tensioning cylinder 106. This mechanism is shown more clearly in FIGS. 5 and 6.

FIG. 5 shows elements of a chain-drive transmission, tensioning mechanism, and conveyance. Since FIG. 5 is a sectional view through power unit 30, it shows elements inboard of housing 78 not visible in previous figures.

Differential output shaft 39 extends through the inner sidewall of housing 78 and is fitted on its end with transmission drive sprocket 96. Rotating axle 76 is carried in bearings 126 mounted with seals in the sidewall of housing 78, as is shown in detail in FIG. 8. Driven transmission sprocket 100 is fixed on axle 76. Roller drive chain 102 is disposed about drive sprocket 96 and driven sprocket 100. Sealed housing 78 also serves as an oil bath, allowing the chain and sprockets to be bathed in oil continuously during operation.

Power unit 30 is substantially symmetrical about a longitudinal axis through housing 78. Thus the outer conveyance elements described in FIG. 4 have mirror image inner counterparts. Shown in FIG. 5 are an inner drive wheel 108, an inner track drive sprocket 110 carrying inner drive bars 112 affixed to sprocket teeth 114 and to inner drive wheel 108. An inner bogie assembly comprising inner bogie swing arm 116, inner bogie wheels 118, and inner bogie wheel axles 120 is shown disposed on the inner end of bogie fixed axle 88. An inner idler wheel 122 and its hub 124 are shown disposed on the inner portion of axle 86.

As noted previously, idler fixed axle 86 is mounted at the forward end of telescoping structural member 75, and is retained there by clamp 104. Telescoping member 75 moves within a fixed outer member 75' rigidly attached to housing 78. Hydraulic tensioning cylinder 106 is connected by shackles to housing 78 at its rear end and to telescoping member 75 at its forward end. Cylinder 106 is controllably supplied with high pressure hydraulic fluid (not shown), whereby axle 86 is urged away from axle 76 to maintain proper tension in endless track 60.

FIG. 6 is a fragmentary perspective view, partially in section, of a portion of power unit 30, showing the longitudinal symmetry of the power unit about housing 78 and its relationship to differential 36 and fixed sleeve 41.

FIG. 6 also shows the design of the inner surface of endless track 60 and how it relates to a portion of the drive and conveyance elements described in FIGS. 4 and 5. Outer drive lugs 62 are formed in a row along the outer edge of the inner surface of track 60. The purpose of lugs 62 is to mesh with drive bars 64 and teeth 66 on track drive sprocket 68. A mirror image inner row of lugs 164 (not shown in FIG. 6) is formed on track 60 to mesh with the counterpart inner drive elements previously described. The load bearing conveyance elements comprising outer and inner drive wheels 77 and 108, outer and inner bogie wheels 92 and 118 (not shown), and outer and inner idler wheels 80 and 122 (neither shown) run against the inner surface of track 60 between the two rows of lugs, thereby distributing the vertical load onto the track and providing lateral stability for the track lugs against the sides of these elements.

FIG. 7 is a horizontal sectional view of power unit 30 showing the relationship of inner and outer drive and conveyance elements to the structural housing and to the inner surface of the track. It also shows the relationship of the differential and its fixed sleeve to the structural housing. For clarity of presentation, the power unit elements in FIG. 7 are described in greater detail in FIGS. 8, 9, and 10.

FIG. 8 shows details of the bearings and seals which permit axle 76 to rotate through sealed housing 78. The assembly is designed to have the inner bearings and seals installed prior to installation of the axle and transmission drive sprocket.

Inner bearing 126 is pressed into inner bearing retainer 128 which also comprises inner shaft face seal 130. The openings in the inner and outer walls of housing 78 are sized for insertion of inner bearing retainer 128 from the outside of power unit 30. Retainer 128 is secured to inner retainer ring 136 by bolts 138, and ring 136 is secured to housing 78 by bolts 140. Rotating axle 76 comprising inner and outer bearing lands 142 and 144 and having been previously fitted with driven sprocket 100 is inserted through inner bearing 126. Outer bearing retainer ring 146 is secured to the outer wall of housing 78 by bolts 148. Outer bearing retainer 150 comprising outer bearing 152 and outer shaft face seal 154 is secured to retainer ring 146 by bolts 156. The hub 111 for inner track drive sprocket 110 is mounted onto the inner end of axle 76, and the assembly of drive sprocket 110 and drive wheel 108 is secured to hub 111 by bolts 158. Similarly, the hub 74 for outer track drive sprocket 68 is mounted on the outer end of axle 76, and the assembly of sprocket 68 and drive wheel 77 is secured to hub 74 by bolts 160.

FIG. 8 also shows outwardly flared flanges 162 at the outer rim of outer drive wheel 77 and the inner rim of inner drive wheel 108. These flanges alternate with drive bars 64 and 112, and provide lateral stability of the drive wheels between outer drive lugs 62 and inner drive lugs 164.

FIG. 9 shows the arrangement of elements by which power unit 30 is attached to differential 36 (not shown). Shaft sleeve 41 comprises sealing land 166, inner bearing land 168, and outer bearing land 170. Sleeve 41 is threaded at its outer end to accept retainer nut 172 and locking nut 172'. Hub 174 containing inner bearing 176, outer bearing 178, and sleeve seal 180 is fitted to sleeve 41 and secured by nuts 172 and 172'. After power unit 30 is properly aligned with differential 36, hub 174 is secured to thrust plate 181 on housing 78. This is the only structural connection of power unit 30 to vehicle 10. Its design and location at substantially the longitudinal center of power unit 30 permits unit 30 to oscillate freely about sleeve 41 in response to variations in terrain.

Differential power output shaft 39 is adapted to receive shaft bearing 182 in shaft bearing retainer 184, which is secured to hub 174 by bolts 186. These bolts are accessible through access opening 188 in housing 78. Transmission drive sprocket 96 also is fitted and secured to the end of drive shaft 39 through opening 188.

FIG. 10 shows the arrangement of bearings and seals whereby outer and inner idler wheels 80 and 122 are mounted on idler axle 86. When assembly is complete, all bearing surfaces are sealed from external contamination. Axle 86 is secured to telescoping structural member 75 by clamp 190 and bolts 192, as is also shown isometrically in FIG. 6. Inner and outer environmental seals 194 and 196 are fitted to axle 86 on opposite sides of member 75 and secured by bolts 198. Inner idler wheel hub 124 adapted as a bearing retainer for first and second inner idler wheel bearings 202 and 204 is fitted to axle 86 and secured by thrust washer 206 and castellated axle nut 208 which is torque-loaded and pinned on the threaded inner end of axle 86. Inner idler wheel 122 is secured to hub 124 by bolts 210. Protective cap 212 is placed over nut 208 and secured to hub 124 by bolts 214.

Similarly, outer idler hub 84 containing first and second outer idler wheel bearings 216 and 218 is fitted to axle 86 and secured by thrust washer 220 and castellated axle nut 222 which is torque-loaded and pinned on the threaded outer end of axle 86. Outer idler wheel 80 is secured to hub 84 by bolts 82. Protective cap 226 is placed over nut 222 and secured to hub 84 by bolts 228.

FIG. 11 shows the mechanical relationship of differential 36, chassis 34, and power unit 30. Sleeve 41 of differential right side power output shaft 39 is rigidly secured to chassis 34 by means of clamp 42. The differential is also similarly secured to the left side of the chassis (not shown) such that there can be no relative motion between the differential and the chassis. Power unit 30 is disposed on the ends of sleeve 41 and shaft 39 as previously described regarding FIG. 9.

FIG. 11 also shows the disposition of inner and outer bogie wheels 118 and 92 on bogie axle 88 symmetrically about housing 78 in power unit 30, and the vertical and lateral support afforded power unit 30 by the action of both bogie assemblies between the two rows of lugs 62 and 164 on endless track 60.

What is claimed is:

1. A power unit for a tracked vehicle comprising:

a) a housing capable of supporting said unit and disposed longitudinally in said unit comprising
   i) a first lateral bore near a first end of said housing,
   ii) a first fixed axle laterally disposed on said housing near a second end thereof, and extending beyond opposite sides of said housing,
   iii) a second lateral bore at a longitudinally central location of said unit;
   iv) a second fixed axle laterally disposed on an underside of said housing at a longitudinally central location of said unit, and extending laterally beyond the sides of said housing;

b) a rotatable axle disposed in said first lateral bore and extending beyond said opposite sides of said housing;

c) a chain drive transmission disposed within said housing comprising
   i) a drive sprocket, the axis of rotation of which is disposed on the centerline of said second lateral bore,
   ii) a driven sprocket fixed on said rotatable axle, and
   iii) a drive chain operationally connecting said drive sprocket and said driven sprocket;

d) first and second toothed drive wheels coaxially disposed and fixed on said rotatable axle on opposite sides of said housing;

e) first and second idler wheels disposed on said first fixed axle on opposite sides of said housing; and

f) an endless track disposed with an inner surface there in contact with said toothed drive wheels and said idler wheels, and having lugs formed on a portion of said inner surface, said lugs being spaced to mesh with said toothed drive wheels, whereby said endless track is caused to rotate in response to power applied to said power shaft.

2. A power unit of claim 1 wherein said chain drive transmission is disposed on substantially the longitudinal centerline of said power unit.

3. A power unit of claim 1 further comprising first and second bogies disposed on said second fixed axle on opposite sides of said housing.

4. A power unit of claim 1 wherein said endless track comprises an elastomeric material.

5. A power unit of claim 4 wherein said elastomeric material comprises rubber or plastic.

6. A power unit of claim 1 further comprising means for establishing and maintaining tension in said endless track.

7. A power unit of claim 1 wherein said housing provides a sealed container for an oil bath for said chain drive transmission.

8. A power unit of claim 1 wherein said lugs on said inner surface of said endless track are disposed in first and second rows, one row along each edge of said inner surface, wherein said lugs are engaged by said first and second toothed drive wheels, respectively.

9. A power unit of claim 1 wherein each of said first and second toothed drive wheels comprises:

a) a hub disposed on and fixed to said rotatable axle;

b) a track drive sprocket having teeth and valleys and disposed coaxially on said hub;

c) a driven road wheel having outwardly flared, separated, inwardly-directed radial flanges on an inner surface thereof, said driven road wheel being in operational contact with the inner surface of said track and disposed inboard of said track lugs; and

d) bars affixed on and transversely to each of said teeth and between each of said radial flanges of said driven road wheel whereby said road wheel is affixed to said track drive sprocket, the spacing of said teeth and said lugs being chosen to cause said teeth and bars to mesh with said lugs on said endless track.

* * * * *

United States Patent [19]

Satzler

[11] **Patent Number:** **4,537,267**

[45] **Date of Patent:** **Aug. 27, 1985**

[54] **BELT TENSIONING MECHANISM**

[75] Inventor: **Ronald L. Satzler**, Princeville, Ill.

[73] Assignee: **Caterpillar Tractor Co.**, Peoria, Ill.

[21] Appl. No.: **563,719**

[22] Filed: **Dec. 20, 1983**

[51] **Int. Cl.**³ **B62D 55/08**

[52] **U.S. Cl.** **180/9.1**; 305/10; 305/29

[58] **Field of Search** 180/9.1; 305/10, 29, 305/30, 31, 32

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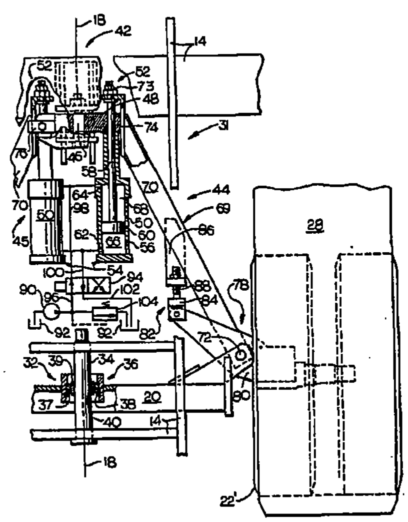
Primary Examiner—John A. Pekar

Attorney, Agent, or Firm—J. W. Burrows

[57] **ABSTRACT**

A belt tensioning mechanism is provided for use with a vehicle having an axle pivotably connected to a frame of the vehicle with inextensible belts entrained about wheel assemblies mounted on either side of the vehicle for transmitting tractive effort to the earth. Some systems provide tensioning of belts by producing a separating force between only the wheel assemblies on one side of the vehicle independent from the tensioning of the other side while others provide tensioning of track having sprocket driving members by using bulky complicated mechanisms for providing the tensioning of the track and to provide relative motion of the front axle from one side to the other. In the subject arrangement, an axle is connected to a frame by a swivel bearing being slidably disposed on a pin, such that, the axle moves longitudinally relative to the frame while still being able to swivel about the pin. Furthermore, an adjusting mechanism is provided to produce the force necessary to sufficiently tension the belts to provide frictional drive between the belts and the drive wheel assemblies. In one of the embodiments, the adjusting mechanism includes a force generating mechanism responsive to fluid pressure transmitted thereto from a pump. This arrangement allows the axle to move relative to the frame in the longitudinal direction in the event that a foreign object passes between one of the belts and its respective wheel assembly without requiring a large bulky mechanism that would be impractical for use on large industrial vehicles.

13 Claims, 3 Drawing Figures



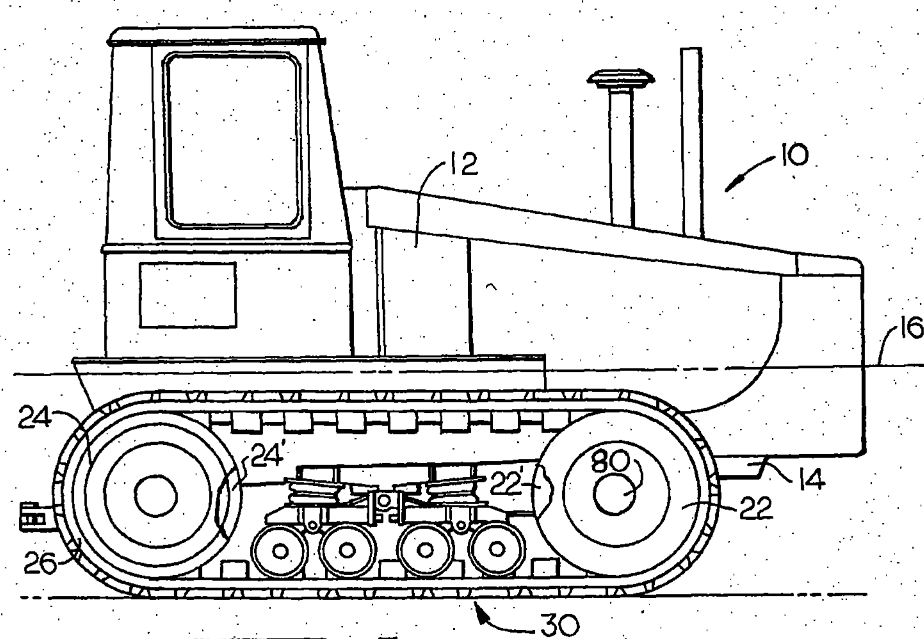

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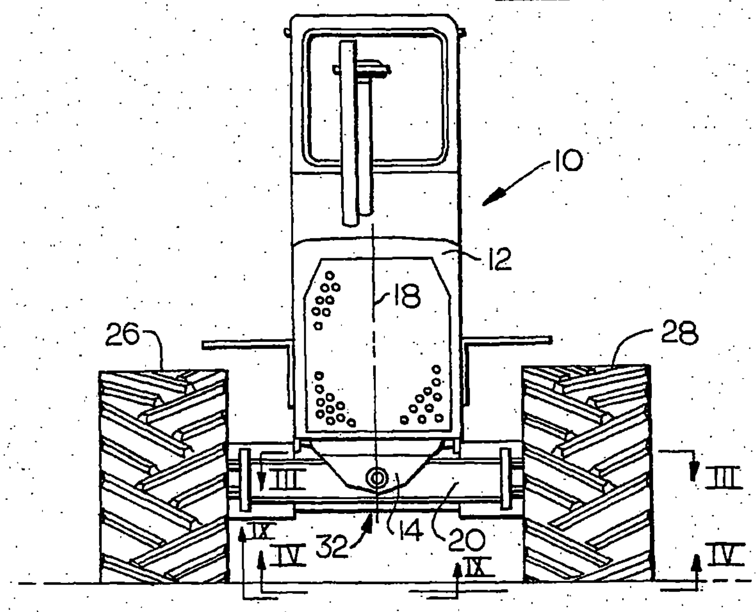
Fig-1

Fig-2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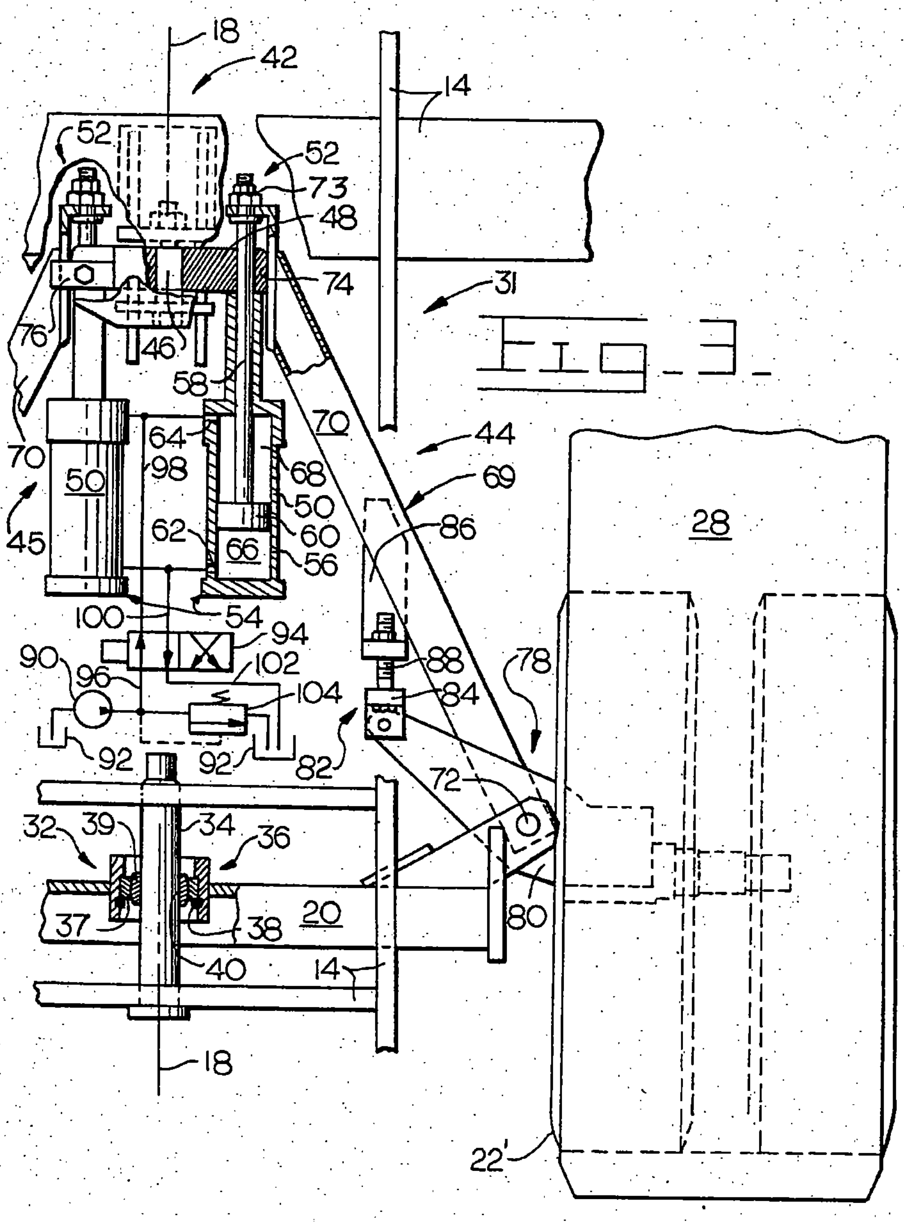
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FIG. 3.

BELT TENSIONING MECHANISM

DESCRIPTION

1. Technical Field

This invention relates to crawler-type vehicles, tractors or equipment using track as opposed to wheels for providing both ground support and tractive effort, and more particularly, to vehicles having an axle extending across the vehicle with a belt tensioning mechanism provided for tensioning the belts.

2. Background Art

Work vehicles as opposed to vehicles for personnel transport are generally intended to push or pull other equipment or earth, or carry a load. Consequently, these vehicles require high tractive forces between the vehicle and the terrain that is being travelled. When using a belted track to increase tractive force, a high load must be generated in the belt in order to minimize slippage between the belted track and the drive wheels. Various types of tensioning mechanisms have been suggested for use on track-type vehicles and on belt-type vehicles to tension each track independently. However, these vehicles do not use a single axle extending across the vehicle.

Vehicles using a track tensioning mechanism in conjunction with a single axle extending across are illustrated in U.S. Pat. No. 1,401,625 issued Dec. 27, 1921 to J. Mader. The vehicle illustrated in this patent is a small garden tractor and includes a sprocket drive which does not rely on friction to provide belt drive, but utilizes a complex and bulky mechanism to provide tensioning of the track and further provide recoil when objects pass between the sprocket drive and the track. When attempting to utilize apparatus of this type in large industrial vehicles, the components would be unreasonably large and bulky thus prohibiting their practical use.

The present invention is directed to overcoming one or more of the problems as set forth above.

DISCLOSURE OF THE INVENTION

In one aspect of the present invention a belt tensioning mechanism is provided for use on a vehicle having a frame defining a plane aligned along its longitudinal axis. An axle is connected to the frame at one end of the vehicle and extends thereacross through the plane. A first pair of wheel assemblies are rotatably mounted on opposite ends of the axle and a second pair of wheel assemblies are driveably rotatably mounted on opposite sides of the frame at the other end of the vehicle. First and second inextensible belts are respectively entrained about the wheel assemblies on each side of the vehicle. A means is provided for connecting the axle to the frame so that the axle is free to swivel and to slide longitudinally relative to the frame and the centrally disposed plane. Also, a means is provided for adjusting the position of the axle relative to the frame to maintain at least a predetermined tension in the first and second belts while permitting the swiveling and longitudinal movements of the axle.

The present invention provides a tensioning mechanism which allows the axle to swivel about a locus relative to the frame and further allows the axle to move longitudinally relative to the frame for absorbing any motions created by one end of the axle moving in a longitudinal direction. Furthermore, the tensioning mechanism is compact while still having the ability to produce high forces for tensioning the belts. The entire mechanism utilized for tensioning and swiveling of the axle is relatively simple in construction and does not require large bulky components. This arrangement provides the high forces necessary for tensioning the belts while still allowing the axle to move relative to the frame whenever an object such as a rock, limb or board passes between the belt and the wheels.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side elevational view of a vehicle utilizing the embodiments of the present invention;

FIG. 2 is a front elevational view of the vehicle illustrated in FIG. 1; and

FIG. 3 is a plan view showing a portion of the vehicle encompassing an embodiment of the present invention taken generally along the line III—III in FIG. 2.

BEST MODE FOR CARRYING OUT THE INVENTION

Referring now to the drawings and more particularly to FIGS. 1 and 2, a work vehicle **10** is shown having a chassis **12** and a frame **14** which constitutes a portion of the chassis **12**. The frame defines a longitudinal axis **16** and a plane **18** centrally disposed along the longitudinal axis **16**.

The vehicle includes an axle **20** connected to a front portion of the frame **14** and has a first pair of wheel assemblies **22,22'** rotatably connected to opposite ends of the axle **20**. A second pair of wheel assemblies **24,24'** are respectively connected to opposite sides of a rear portion of the frame **14**. First and second inextensible belts **26,28** are respectively entrained about the wheel assemblies **22,24,22',24'** on each side of the vehicle **10**. A bogie system **30** is rotatably connected to the frame **14** on each side of the vehicle **10** and in load sharing contact with the respective belts **26,28** to share the loads being placed on the belts from the load of the vehicle as it negotiates the terrain.

Referring now to FIG. 3, a belt tensioning mechanism **31** is illustrated which more clearly shows an embodiment of the present invention. A means **32** is provided for connecting the axle **20** to the frame **14** so that the axle **20** is free to swivel and to slide longitudinally relative to the frame. The connecting means **32** includes a pin **34** connected to the frame **14** parallel to the longitudinal axis **16** and along the centrally disposed plane **18**. The connecting means **32** also includes a swivel bearing **36** connected to the axle **20** and slidably disposed on the pin **34**. The swivel bearing **36** includes a race **37** secured to the axle **20** by a snap ring **38** and a spherical bearing member **39** defining a bore **40** adapted to slidably mount on the pin **34**.

A means **42** is provided for adjusting the axle **20** relative to the frame **14** to maintain at least a predetermined tension on the first and second belts **26,28**, while permitting the swiveling and longitudinal movements of the axle **20**. The adjusting means **42** includes a force generating mechanism **44** connected between the frame **14** and the axle **20**.

The force generating mechanism **44** includes a jack mechanism **45** pivotably connected at one end to the frame **14** along the centrally disposed plane **18**. The jack mechanism **45** includes a pivot pin **46**, such as a bolt, dowell, etc., connected to the frame **14** along the centrally disposed plane **18** longitudinally remote from and in axial alignment with the pin **34**. The jack mechanism **45** also includes a force transmitting member **48** pivota-

bly mounted on the pivot pin 46 and a pair of jack assemblies 50.

Each of the jack assemblies 50 has a rod end portion 52 and a head end portion 54. Each of the jack assemblies 50 further includes a housing 56 and a rod 58 connected to a piston 60 which is slidably disposed in the housing 56. The head end portion 54 is generally defined by the housing 56 while the rod end portion 52 is generally defined by the rod 58. The housing 56 of each jack assembly 50 defines first and second ports 62,64 respectively in communication with head and rod end pressure chambers 66,68 which are separated by the piston 60. The housing 56 of each jack assembly is connected to opposite ends of the force transmitting member 48 while the rod 58 of each jack assembly 50 slidably extends through the force transmitting member 48 at the location of the connection with the housing 56.

The force generating mechanism 44 also includes a force transfer mechanism 69, such as, a pair of force transmitting arms 70 each respectively connected to opposite ends of the axle 20 by respective pin joints, one shown at 72. The other end of each of the force transmitting arms 70 is connected to the rod 58 of each of the jack assemblies 50 by locking nuts 73 in a known manner. The arms 70 each respectively has a surface 74 in sliding contact with the opposite ends of the force transmitting member 48. A plurality of retainers 76 are secured to the member 48 and adapted to maintain the sliding and alignment relationship between the surface 74 of the arms 70 and the opposite ends of the member 48.

Additionally, the force generating mechanism 44 includes a means 78 for aligning each of the first pair of wheel assemblies 22,22' relative to the belts 26,28. The alignment means 78 includes a pair of spindles 80 each pivotally connected to the opposite ends of the axle 20 at the respective pin joint 72 and a pair of adjusting assemblies 82 each being connected between the respective spindle 80 and the associated one of the force transmitting arms 70. The adjusting assembly 82 includes a first bracket 84 secured to the other end of the spindle 80 and a second bracket 86 secured to the arm 70 with an adjustable fastener member 88 connected between the brackets 84,86. As shown, the fastener member 88 is a bolt and nut, but it is recognized that the fastener member 88 could be replaced with other known adjustable fastening means. Each of the spindles 80 has the respective wheel assembly 22/22' rotatably connected to one end thereof.

The force generating mechanism 44 additionally includes a source of pressurized fluid, such as a pump 90, which draws fluid from a tank 92 in a conventional manner and delivers presssurized fluid to a switching valve 94 through a conduit 96. A pair of conduits 98,100 respectively connect the switching valve 94 to the inlet ports 64,62 of the jack assemblies 50. The switching valve 94 is connected to the tank 92 in a conventional manner by a conduit 102 and may be actuated either manually, electrically or hydraulically. A relief valve 104 is connected to the conduit 96 and adapted to control the pressure in the conduit 96 to a predetermined maximum level.

From a review of the Figs. and the above description, it is readily apparent that numerous modifications and/or combination of elements could be combined without departing from the essence of the invention. For example, various forms of hydraulic circuits could be utilized to extend and/or retract the cylinder disclosed herein without departing from the essence of the invention.

INDUSTRIAL APPLICABILITY

In the use of work vehicles of this type, the belt tensioning mechanism 31 as shown in the various embodiments herein is necessary to provide the high tensions in the belt to prevent slippage between the drive wheels 24,24' and the first and second belts 26,28. The tensioning mechanism 31 must generate sufficient tension in each of the belts 26,28 so that there is a satisfactory frictional driving force between the drive wheels 24,24' and the respective belt 26/28. For example, in one vehicle having a gross weight of 115.7 kN (26,000 lbs.) and a belt width of 61 cm (25 inches), an initial tension of 44.5 kN (10,000 lbs.) in each of the belts operated successfully. It is recognized that different size belts would vary in total force needed in the belt to maintain the frictional driving force between the belts 26,28 and the respective wheel assemblies. Furthermore, it is necessary to provide recoil of one side of the axle 20 in the event an object such as a rock, limb, board, etc. passes between one of the belts 26/28 and the respective wheel assembly 22/24,22'/24'.

Referring more specifically to the operation of the embodiment shown in FIG. 3, fluid pressure from the pump 90 is directed to the pressure chambers 68 of the jack assemblies 50 generating a force on the piston 60 which is transferred through the rod 58 and the arms 70 to the axle 20. The bore 40 of the spherical bearing member 39 allows the axle 20 to slide relative to the pin 34. Consequently, the force transmitted to the axle 20 is further transferred through the spindles 80 to the pair of wheel assemblies 22,22' and tensions the first and second belts 26,28. The relief valve 104 controls the maximum pressure in the pressure chambers 68 and consequently controls the tension in the belts 26,28.

When a foreign object passes between, for example, the belt 28 and the wheel assembly 22', the spindle 80 that is connected to the wheel assembly 22' moves towards the second wheel assembly 24'. It is recognized that if pneumatic tires are being used in the wheel assembly 22' that the tires will take a portion of the recoil and in many cases will be sufficient to absorb all of the recoil needed. In the event that the spindle 80 which is connected to the axle 20 moves towards the second wheel assembly 24', the axle 20 pivots about the other wheel assembly 22 and slides relative to the pin 34 without inducing any bending moments in the axle 20. Simultaneously therewith the arm 70 slides along the surface 74 relative to one end of the force transmitting member 48 causing extension of the rod 58 relative to the housing 56 against the bias of the pressure in the pressure chamber 68. The fluid displaced in the pressure chamber 68 as a result of the movement of the rod 58 is forced out the port 64 to the tank 92 through the conduit 98, the switching valve 94 and the relief valve 104. Since the setting of the pressure relief valve 104 has not changed, the force on the axle 20 through the arm 70 does not change with the above-noted movement. As the foreign object moves out from between the belt and wheel assembly, the axle 20 returns to its original position by fluid under pressure entering the pressure chamber 68 causing movement of the piston 68, rod 58, arm 70, and axle 20.

The swivel bearing 36 further allows the axle 20 to pivot about the pin 34 in the event one of the wheel assemblies 22,22' runs over a raised object on the

ground. The force transmitting member **48** pivots about the pivot pin **46** thus allowing the jack assemblies **50** and arms **70** to pivot simultaneously with any pivoting movement of the axle **20** about the pin **34**.

In the event that tensioning of the belts **26,28** cause relative misalignment of the rotating axis of the wheel assemblies **22,22'**, the adjusting assemblies **82** are adjusted in order to move the wheel assembly **22/22'** about the pivot point **72** to realign the respective wheel assembly **22/22'**.

If it is desirable to change one or both of the belts **26,28**, the switching valve **94** is moved to its other position thus directing pressurized fluid to the pressure chambers **66** of the jack assemblies **50**. The pistons **60** and associated rods **58** resulting in the axle **20** moving along the pin **34** towards the second pair of wheel assemblies **24,24'**. After the new belt(s) have been installed, the switching valve **94** is returned to the original position thus directing the pressurized fluid into the pressure chambers **68** of the jack assemblies **50** to tension the belts as previously described.

In view of the foregoing, it is readily apparent that the belt tensioning mechanism **31** shown and described in the various embodiments provides a simple mechanism having the ability to provide high tensioning forces in the belts **26,28** while still allowing the axle **20** of the vehicle **10** to swivel and slide in a longitudinal direction relative to the frame **14** of the vehicle **10** to compensate for recoil action of one of the wheel assemblies **22,22'** relative to the other.

Other aspects, objects and advantages of this invention can be obtained from a study of the drawings, the disclosure and the appended claims.

I claim:

1. A belt tensioning mechanism for use on a vehicle having a frame defining a plane aligned along its longitudinal axis, an axle connected to the frame at one end of the vehicle and extending thereacross through said plane, a first pair of wheel assemblies rotatably mounted on opposite ends of the axle independent of said frame, a second pair of wheel assemblies drivably mounted on opposite sides of the frame at the other end of the vehicle, and first and second inextensible belts respectively enstrained about the wheel assemblies on each side of the vehicle, comprising:

- means for universally swiveling said axle relative to said frame and said centrally disposed plane and for sliding said axle longitudinally relative to said frame and said centrally disposed plane; and
- means for adjusting the position of said axle relative to said frame to maintain at least a predetermined tension in said first and second belts while permitting said universal swiveling and longitudinal movements of said axle.

2. The mechanism, as set forth in claim **1**, wherein the connecting means includes a pin and a universally swiveling bearing slidably mounted on the pin, one of said pin and swivel bearing being secured to said axle at a point midway between the ends of the axle and the other of said pin and swivel bearing being secured to said frame at the one end of the vehicle along said centrally disposed plane.

3. The mechanism, as set forth in claim **2**, wherein the adjusting means includes a force generating mechanism connected between the frame and the axle and being adapted to move the axle relative to the frame to establish the predetermined tension in the first and second belts.

4. The mechanism, as set forth in claim **3**, wherein the force generating mechanism includes a jack mechanism pivotably and operatively connected at one end to said frame along said centrally disposed plane and a force transfer mechanism connected to opposite ends of the axle and operatively connected to the other end of said jack mechanism.

5. The mechanism, as set forth in claim **4**, wherein the jack mechanism includes a pivot pin connected to the frame along the centrally disposed plane longitudinally remote from and in axial alignment with said pin, a force transmitting member pivotably mounted on said pivot pin, and a pair of jack assemblies each respectively connected between opposite ends of the force transmitting member and the force transfer mechanism.

6. The mechanism, as set forth in claim **5**, wherein the force transfer mechanism includes a pair of force transmitting arms each connected between one of the jack assemblies and one of the ends of the axle.

7. The mechanism, as set forth in claim **6**, wherein each of the jack assemblies includes a rod end portion and a head end portion with one of the end portions of the jack assemblies being connected to the opposite ends of the force transmitting member and the other of the end portions of the jack assemblies being connected to the respective force transmitting arms.

8. The mechanism, as set forth in claim **7**, wherein each of said jack assemblies is adapted to generate at least a predetermined force on the axle for tensioning said first and second inextensible belts and is independently movable in response to one end of the axle moving longitudinally relative to said frame while maintaining at least said predetermined tension on said first and second belts.

9. The mechanism, as set forth in claim **8**, wherein the force generating mechanism includes means for aligning each of said first pair of wheel assemblies relative to said belt so that said wheel assemblies are maintained in alignment with said belt.

10. The mechanism, as set forth in claim **9**, wherein each of said force transmitting arms is pivotably connected to the axle by a pin joint and said aligning means includes a pair of spindles respectively pivotably connected to each end of the axle and having the respective wheel assemblies rotatably mounted on one end of each spindle, and a pair of adjusting assemblies respectively connected between each spindle and the respective force transmitting arms.

11. The mechanism, as set forth in claim **10**, wherein each of said spindles is connected to the axle at the respective pin joint and each of said adjusting assemblies are connected to the other end of the spindles.

12. The mechanism, as set forth in claim **10**, wherein said pair of jack assemblies are operative to selectively retract said axle and said first pair of wheel assemblies relative to said second pair of wheel assemblies so that said first and second belts may be changed.

13. The mechanism, as set forth in claim **12**, wherein said pin is attached to the frame and said swivel bearing is attached to said axle.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 4,537,267

DATED : August 27, 1985

INVENTOR(S) : Ronald L. Satzler

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 5, line 41: after "drivably" insert --rotatably--.

Column 5, line 44: delete "enstrained" and insert --entrained--.

Signed and Sealed this

Fifteenth **Day of** *April 1986*

[SEAL]

Attest:

DONALD J. QUIGG

Attesting Officer *Commissioner of Patents and Trademarks*

US006318484B2

(12) **United States Patent**
Lykken et al.

(10) **Patent No.: US 6,318,484 B2**
(45) **Date of Patent: *Nov. 20, 2001**

(54) **TRACKED SUSPENSION**

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(73) Assignee: **Case Corporation**, Racine, WI (US)

(*) Notice: This patent issued on a continued prosecution application filed under 37 CFR 1.53(d), and is subject to the twenty year patent term provisions of 35 U.S.C. 154(a)(2).

Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **09/399,870**

(22) Filed: **Sep. 20, 1999**

(51) **Int. Cl.**[7] **B62D 55/00**

(52) **U.S. Cl.** **180/9.48**; 180/9.1; 305/120; 305/131; 305/135

(58) **Field of Search** 180/9, 9.1, 9.21, 180/9.46, 9.48, 9.62, 9.26; 305/135, 199, 120, 131, 134, 132, 138

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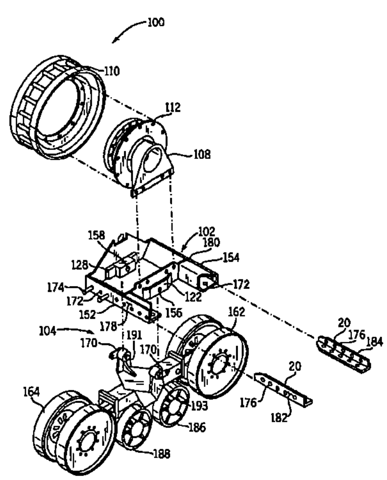
(57) **ABSTRACT**

A tracked suspension for a tractor or other work vehicle is disclosed having an endless belt, a belt tensioner, a drive wheel, and a plurality of idler wheels mounted to a suspension frame or idler carriage, the assembly being arranged such that the belt tension provided by the tensioner is absorbed within the frame and is not transmitted to the axle extending from the tractor that drives the tracked suspension. The tracked suspension can be adjusted by loosening or removing mounting bolts that fix the suspension to beams extending from the vehicle, sliding the suspension toward or away from the vehicle, and tightening the bolts. By absorbing the belt tensioning forces within the tracked suspension itself, rather than transmitting the belt tensioning forces to the axle, the suspension can be more easily adjusted without requiring the removal and replacement of the drive axle.

25 Claims, 4 Drawing Sheets



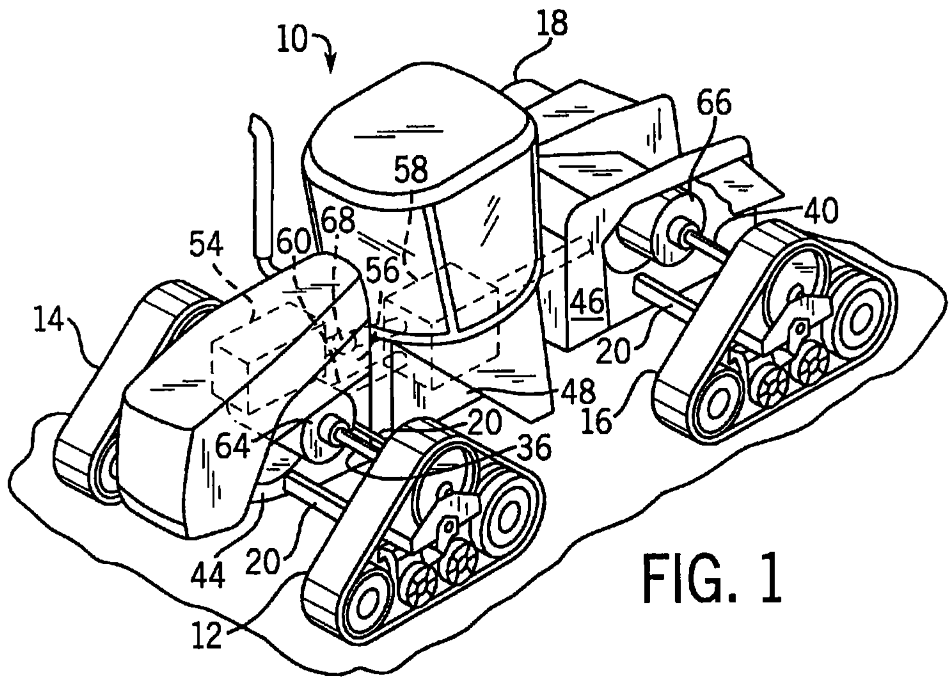

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FIG. 1

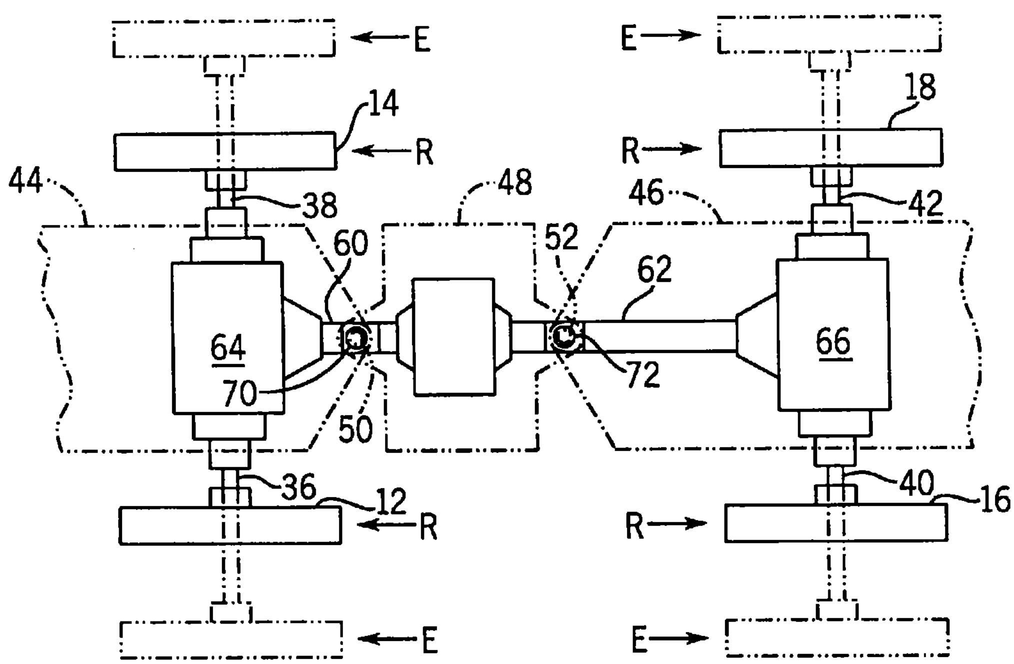
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FIG. 2

FIG. 3

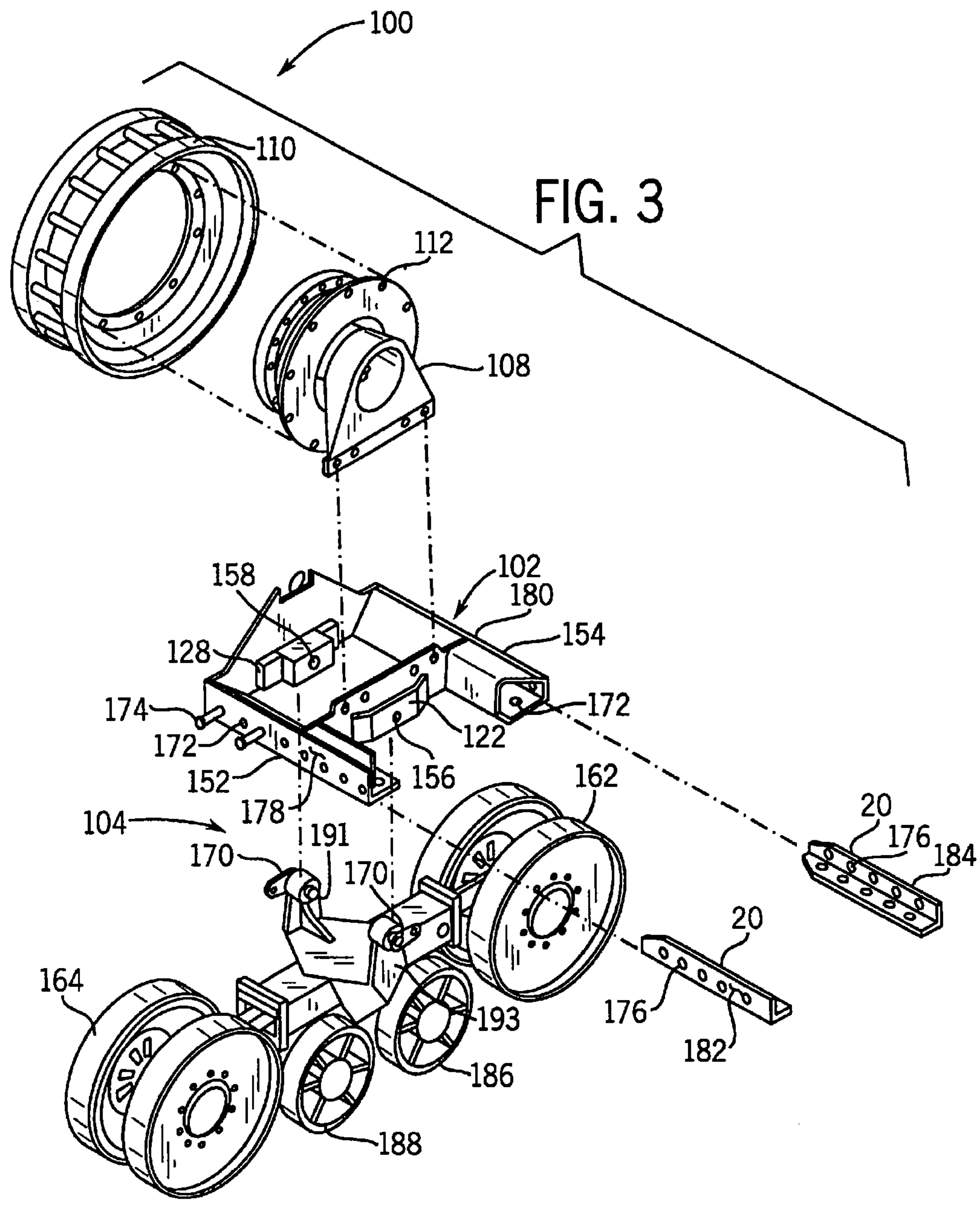
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FIG. 4

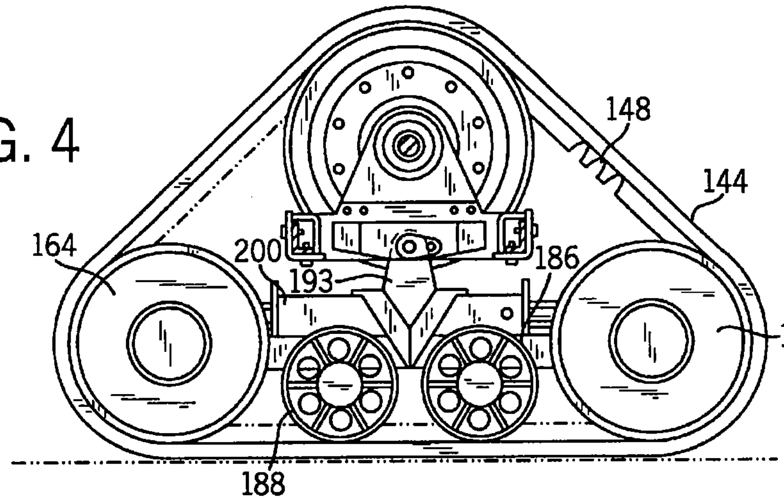
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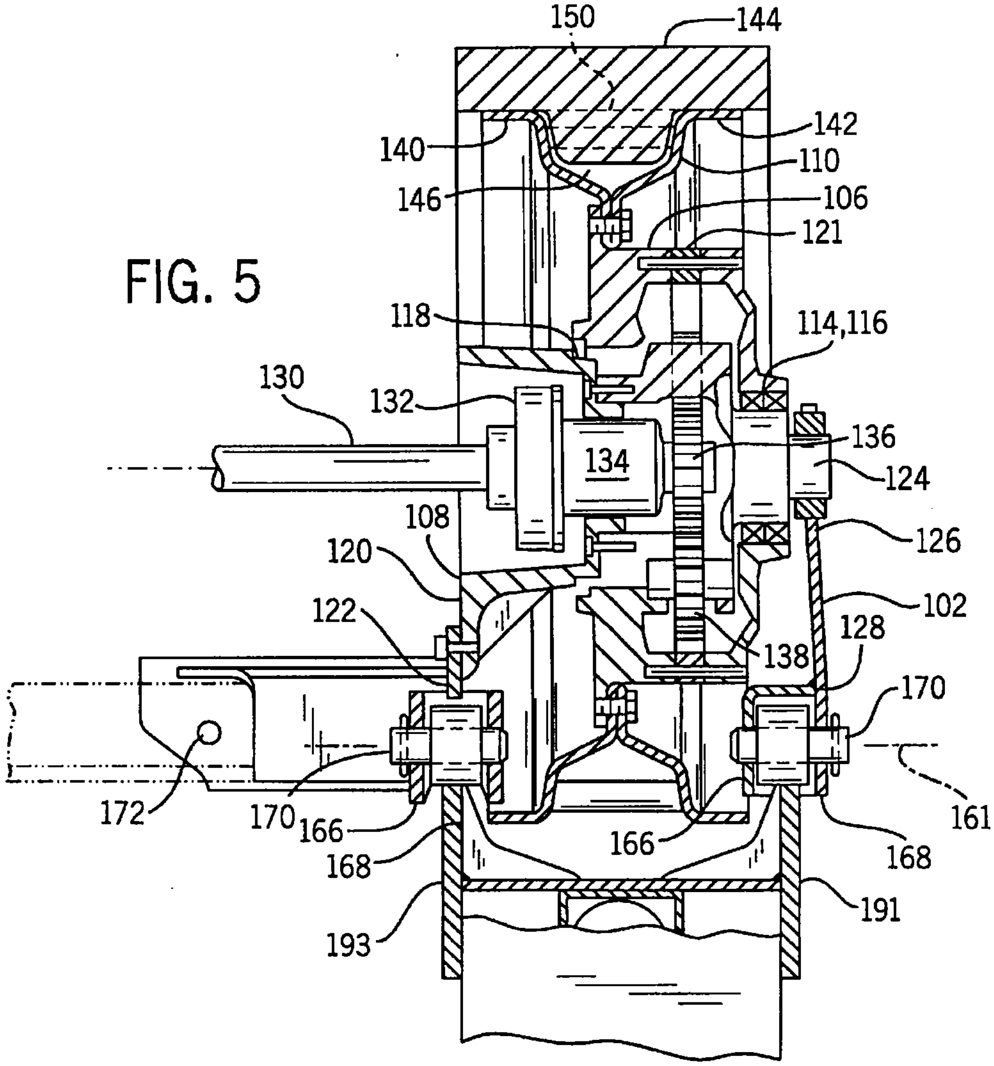
FIG. 5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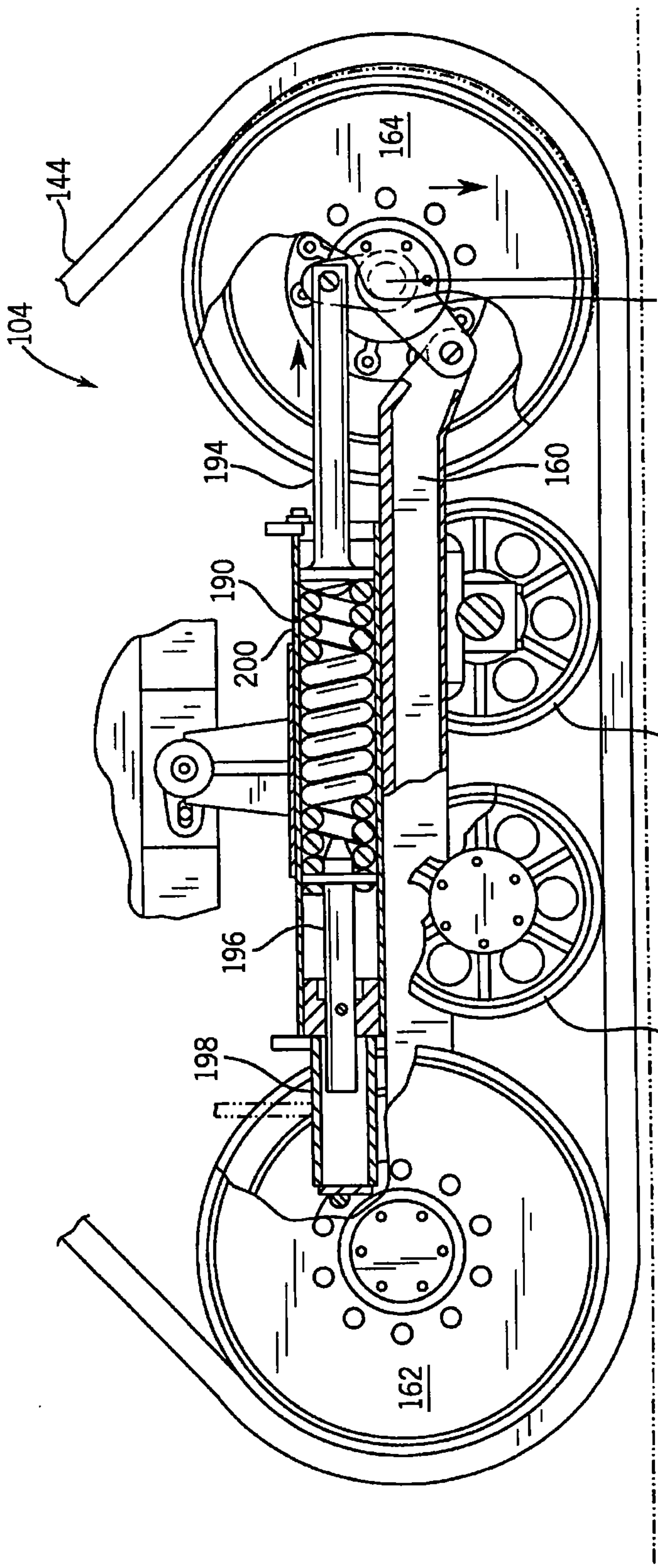

FIG. 6

TRACKED SUSPENSION

FIELD OF THE INVENTION

The invention relates generally to tracked vehicles having adjustable suspensions. More particularly, it relates to agricultural tractors with tracked suspensions having lateral adjustability and internal track strain absorption.

BACKGROUND OF THE INVENTION

Tracked vehicles have been provided for use in agricultural operations that provide a fixed track width. One of the reasons the tracked width is fixed is because the drive axle extending from the vehicle and coupled to the drive wheel is neither easily removable or adjustable since it must be strong enough to resist bending forces applied to it by the track spring tension. It is an object of this invention to provide an agricultural tractor that is more easily adjusted for lateral track width. It is an object of this invention to provide such a tractor by absorbing track tension stresses within the tracked suspension itself, and not transmitting them to the drive axle.

SUMMARY OF THE PRESENT INVENTION

In accordance with the first embodiment of the invention, a tracked suspension for a work vehicle is provided including an endless track, a suspension frame configured to be slidably and fixedly mounted to at least one suspension beam extending from a frame of the vehicle, a beam extending parallel to a direction of travel and pivotally coupled to the suspension frame about a first pivotal axis substantially perpendicular to the direction of travel, a first idler wheel coupled to a fore portion of the beam and rotatable with respect thereto, a second idler wheel coupled to a rearward portion of the beam and rotatable with respect thereto, a belt tensioner configured to tension the endless track, a drive wheel support fixed to the suspension frame, a drive wheel rotatably coupled to the drive wheel support and having a drive wheel rotational axis, and a drive wheel axle rotationally coupled to the drive wheel to drive the drive wheel in rotation, wherein the track tensioner is disposed to tension the track about the periphery of the drive wheel and the first and second idler wheels without transferring tension to the drive wheel axle.

Other principal features and advantages of the invention will become apparent to those skilled in the art upon review of the following drawings, the detailed description and the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of an agricultural tractor in accordance with the present invention having left and right front and left and right rear tracked suspensions, each supported on beams extending from the tractor;

FIG. 2 is a top view of the tractor of FIG. 1, showing the track arrangement of the tracked suspensions, in an extended and retracted position, together with the differentials and transmission;

FIG. 3 is an exploded perspective view of a typical tracked suspension of the tractor of FIGS. 1 and 2;

FIG. 4 is a side view of a typical tracked suspension of the tractor of FIGS. 1–3 from the tractor side of the suspension;

FIG. 5 shows a partial cross-sectional view of a drive wheel and drive wheel support for a typical suspension of the tractor of FIGS. 1–4; and

FIG. 6 is a partial cross-sectional view of an idler beam and associated idler wheels and roller wheels.

Before explaining at least one embodiment of the invention in detail it is to be understood that the invention is not limited in its application to the details of construction and the arrangement of the components set forth in the following description or illustrated in the drawings. The invention is capable of other embodiments or being practiced or carried out in various ways. Also, it is to be understood that the phraseology and terminology employed herein is for the purpose of description and should not be regarded as limiting.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIGS. 1–6, an agricultural tractor **10** is illustrated supported by four tracked suspensions **12, 14, 16, 18**. Each of these suspensions is slidably mounted on two associated beams **20**, extending laterally outward from the vehicle at each suspension point. The beams are preferably disposed in a fore-and-aft arrangement such as that shown from right front suspension **12** in FIG. **1**.

Suspensions **12, 14, 16, 18** are each driven by drive axles **36, 38, 40, 42**. The left front and right front suspensions are coupled to a front frame **44**, the left rear and right rear suspensions are coupled to a rear frame **46**. The left and right front suspension beams are fixed with respect to and extend from front frame **44**. The left and right rear suspension beams are fixed with respect to and extend from rear frame **46**. A middle frame **48** is provided that is pivotally coupled to both front frame **44** and rear frame **46** via two articulation joints **50, 52**. Front articulation joint **50** pivotally couples front frame **44** and middle frame **48** and permits pivotal movement between the two, primarily in a horizontal plane. Rear articulation joint **52** is coupled between middle frame **48** and rear frame **46** and permits pivotal motion between middle frame **48** and rear frame **46**, primarily in a horizontal plane.

Engine **54** is fixedly mounted to front frame **44** and drives the tractor **10**. It is coupled via a drive shaft **56** to transmission **58** which is driven by engine **54**. Transmission **58**, in turn, drives front drive shaft **60** and rear drive shaft **62**. Front drive shaft **60** is coupled between transmission **58** and front differential **64** and transmits power from transmission **58** to front differential **64** to drive front differential **64**. Rear drive shaft **62** is similarly coupled between transmission **58** and rear differential **66** and transmits power from transmission **58** to rear differential **66**.

Front differential **64** drives laterally opposed left front suspension **12** and right front suspension **14**. Rear differential **66** drives laterally opposed left rear suspension **16** and right rear suspension **18**. Each of the three drive shafts **56, 60, 62** includes a flexible coupling **68, 70, 72** disposed in its length to permit relative motion between the differentials and the transmission and between the transmission and the engine to allow the front, middle and rear frames to pivot with respect to each other about their flexible couplings.

Each of the four tracked suspensions **12, 14,16,** and **18** are preferably the same, a single example of which is illustrated in FIGS. 3–6. The discussion below is directed to single suspension, but applies equally to all four. The tracked suspensions on the left side are mirrored on the right side of the vehicle. Internal details of the front and rear differentials are disclosed in the application entitled "Track Vehicle Track Width Adjustment," Ser. No. 09/400,510, filed contemporaneously herewith and incorporated herein by reference for all that it teaches.

Each tracked suspension includes a drive wheel assembly **100** mounted on an idler wheel carriage **102** which supports the idler and roller wheels. The idler wheel carriage is slidably supported on two beams **20** that extend laterally from the front or rear frame of the vehicle. Idler wheel carriage **102** is pivotally coupled to idler wheel assembly **104**.

There are two beams extending from the left front of the vehicle which support the left front tracked suspension, two beams that extend from the from the right front of the vehicle that support the right front tracked suspension, two beams that extend from the left rear of the vehicle that support the left rear tracked suspension, and two beams that extend from the right rear of the vehicle that support the right rear tracked suspension.

The drive wheel assembly includes a drive wheel **106** rotationally supported on a drive wheel support **108**. Drive wheel **106** includes a rim **110** that is bolted to drive wheel hub **112** which is supported in rotation by drive wheel support **108**. Drive wheel support **108** is fixedly mounted to idler wheel carriage **102**. Drive wheel **106** is supported on bearings **114**, **116** and **118** which permit the drive wheel to rotate with respect to drive wheel support **108**. Drive wheel **106** is driven by ring gear **121** disposed between and fixedly mounted to inner and outer portions of drive wheel hub **112**. Drive wheel support **108** is fixedly mounted to idler wheel carriage **102** both on the inboard side and the outboard side of drive wheel **106**. On the inboard side, a downwardly extending flange **120** of drive wheel support **108** is fixedly mounted to inboard carriage support **122**. On the outboard side, a cylindrical portion **124** of drive wheel support **108** is fixedly mounted to a plate **126** extending upward from outboard carriage support **128**. Drive wheel support **108** also supports an outboard end of drive axle **130** in rotation. The outboard end of drive axle **130** is rotationally coupled to flexible coupling **132**, which in turn is coupled to stub axle **134**. A sun gear **136** is fixedly mounted to stub axle **134** and engages a plurality of planetary gears **138** (only one shown for convenience) that are supported in rotation by drive wheel support **108**. Planetary gears **138**, in turn, engage and drive ring gear **121**. In this manner, when drive axle **130** is rotated, it drives sun gear **136** in rotation, which drives planetary gears **138** in rotation, which drive ring gear **121** and therefore drive drive wheel hub **112** in rotation.

Rim **110** includes to axially extending flanges **140** and **142** that support and drive track **144**. A recess **146** is located between the two flanges and receives lugs **148** extending inwardly from an inner surface of track **144**. A plurality of axially extending rods **150** extend between and are fixed at both ends with respect to axially extending flanges **140** and **142** and across the recess. Each of these rods **150** engage lugs **148** and drive track **144** about the periphery of drive wheel **106**.

Idler wheel carriage **102** serves as one exemplary suspension frame configured for being removably mounted to a suspension beam and for supporting the drive wheel and the idler wheels of driver **106** and the idler wheels **162**, **164**. Idler wheel carriage **102** includes two laterally extending members (or brackets) **152**, **154** that are coupled to beams **20** extending from the vehicle's frame. Inboard and outboard carriage supports **122** and **128** extend between and are fixedly mounted to laterally extending members **152** and **154**. Carriage support **122** is disposed inboard of drive wheel **106** and carriage support **128** is disposed outboard of drive wheel **106**. Carriage supports **122** and **128** define carriage pivots **156** and **158**, respectively, which pivotally support idler beam **160** of idler wheel assembly **104**. In this manner, idler beam **160** is permitted to rotate about a substantially horizontal pivotal axis **161** that extends laterally with respect to the vehicle and is defined by carriage pivots **156** and **158**. This pivotal axis is preferably disposed below the drive wheel's rotational axis, and above and between the rotational axes of idler wheels **162** and **164**. The pivotal axis preferably intersects the drive wheel. Each of the carriage pivots includes an inboard and outboard pin supports **166**, **168** having holes through which pins **170** are inserted. Pins **170** extend laterally with respect to the vehicle, and are substantially coaxial. Pins **170** are supported at their inner and outer ends by their associated inboard and outboard supports. Each of the laterally extending members **152** and **154** have a plurality of holes **172** through which bolts **174** are inserted. Similarly spaced holes **176** are provided on beams **20** to receive these bolts. To adjust the position of the tracked suspension with respect to the vehicle, the bolts are removed and the suspension is slid inward or outward on beams **20** until a new set of holes on the laterally extending members and the beams are aligned. Surfaces **178** and **180** on laterally extending members **152**, **154** are substantially parallel where intersected by a horizontal plane or planes and mate with similar parallel surfaces **182**, **184** on beams **20**. At this point, the bolts are reinserted in the newly aligned holes and tightened. To make this adjustment relatively trouble free, alignment marks are preferably provided on at least one beam and its corresponding tracked suspension for each of the four suspensions of the vehicle.

Idler wheel assembly **104** includes an elongate horizontally extending idler beam **160** which supports idler wheels **162** and **164** (and roller wheels **186** and **188**) in rotation. Pivot ears **191** and **193** are fixedly mounted to idler beam **160** and extend upwardly and outwardly to pivotally engage carriage pivots **158** and **156**, respectively. In this manner, idler wheel assembly **104** and its two idler and two roller wheels, pivot with respect to drive wheel **106** about the pivotal axis defined by carriage pivots **156** and **158**.

Idler wheels **162** and **164** are biased away from each other by coil spring **190** disposed between the idler wheels and above idler beam **160**. Both idler wheels are in the form of two discs spaced apart from each other and sharing a common rotational axis. A pivotal link **192** is pivotally coupled to an end of idler beam **160**. Idler wheel **164** is rotationally coupled to pivotal link **192**, having a disk disposed on either side of pivotal link **192**. An elongate member **194** is pivotally coupled to an upper end of pivotal link **192** and biases pivotal link **192** outward with respect to idler beam **160**. The inner end of elongate member **194** abuts a first end of spring **190** which pushes the elongate member outward with respect to idler beam **160**. A second end of spring **190** abuts piston rod **196** which extends from and is biased toward spring **190** by hydraulic cylinder **198**. By filling hydraulic cylinder **198** with hydraulic fluid, piston rod **196** is forced out of the cylinder and toward the spring, compressing this spring and biasing idler wheel **164** outward. In this manner, track **144**, which extends about the periphery of idler wheel **162**, idler wheel **164**, and drive wheel **106**, can be appropriately tensioned or pre-loaded. Spring **190** is shrouded by spring housing **200** which extends around the outside of spring **190** on an upper surface of idler beam **160** and keeps dirt and other contaminants from filling the coils of spring **190**. Hydraulic cylinder **198** and spring housing **200** are fixedly mounted to an upper surface of idler beam **160**. Idler wheel **162** is supported by the other end of idler beam **160** and rotates with respect thereto. Roller wheels **186** and **188** are also mounted on bearings to idler beam **160** for rotation with respect to idler beam **160**. These

wheels are disposed between idler wheels **162** and **164** and are also in the form of two discs, one disposed on either side of idler beam **160**.

Each of the above-described suspensions **12, 14, 16** and **18** have a track **144** that is tensioned without the tension being transferred to its corresponding drive wheel axle **36, 38, 40** or **42**. Since each of the wheels in contact with the track **144** (idler wheels **162, 164,** and drive wheel **106** in the illustrated embodiment) are supported by a suspension frame that is supported solely by a suspension beam rather than the drive axle, the track is tensioned without transferring tension to the drive wheel axle. For example, each suspension could theoretically be separated from the suspension beam as well as the drive wheel axle while the track is maintained in tension by the suspension frame, the drive wheel and the idler wheels.

Thus, it should be apparent that there has been provided in accordance with the present invention an improved tracked suspension that fully satisfies the objectives and advantages set forth above. Although the invention has been described in conjunction with specific embodiments thereof, it is evidence that many alternatives, modifications and variations will be apparent to those skilled in the art. Accordingly, it is intended to embrace all such alternatives, modifications and variations that fall within the spirit and broad scope of the appended claims.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A tracked suspension for an agricultural tractor having a frame, a drive wheel axle extending from the frame and a suspension beam extending from the frame, the suspension comprising:

an idler wheel carriage configured to be removably mounted to the suspension beam;

a fore and aft extending idler beam having a forward portion and a rearward portion and pivotally coupled to the idler wheel carriage about a first pivotal axis;

a rear idler wheel pivotally coupled to the rearward portion of the idler beam and rotatable with respect thereto;

a front idler wheel pivotally coupled to the forward portion of the idler beam and rotatable with respect thereto;

a belt tensioner coupled to at least one of the rear idler wheel and the front idler wheel to extend or retract the at least one of the rear idler wheel and the front idler wheel with respect to the idler beam;

at least one roller wheel disposed between the front and rear idler wheels and rotatably coupled to the idler beam;

a drive wheel support mounted to the idler wheel carriage;

a drive wheel rotatably coupled to the drive wheel support and rotating about a drive wheel rotational axis, wherein the drive wheel is configured to be removably coupled to the drive wheel axle; and

an endless track extending about a periphery of the at least one roller wheel, the front and rear idler wheels and the drive wheel.

2. The tracked suspension of claim **1**, wherein the first and second idler wheels have first and second rotational axes extending in first and second vertical planes, respectively, wherein the drive wheel rotational axis is disposed above the first and second rotational axes of the front and rear idler wheels and between the first and second vertical planes, and further wherein the first pivotal axis is disposed below the drive wheel rotational axis.

3. The tracked suspension of claim **2**, wherein the tractor includes a differential, and an axle extending from the differential, wherein the suspension includes:

a sun gear configured to be coupled to the axle;

a ring gear couple to the drive wheel; and

at least one planetary gear operably coupled between the sun gear and the ring gear.

4. The tracked suspension of claim **3**, wherein the beam includes a pivot ear extending from the fore and aft extending beam, and a second pivot ear extending from the fore and aft beam, each of the first and second pivot ears including a pivot at an upper end thereof that defines a first pivotal axis.

5. The tracked suspension of claim **4**, further comprising inner and outer drive wheel bearings configured to support relative rotational motion of the drive wheel with respect to the drive wheel support, and further wherein the ring gear, the sun gear and the planetary gear are disposed laterally between the inner and outer wheel bearings.

6. The tracked suspension of claim **1**, wherein the idler wheel carriage includes forward and rearward laterally extending members adapted to slidably receive the suspension beam extending from the tractor, the forward member disposed forward of and below the drive wheel rotational axis, and the rearward member disposed rearward of and below the drive wheel rotational axis.

7. A tracked suspension for an agricultural tractor having at least one suspension beam extending from a side of the tractor and a drive wheel axle, the suspension comprising:

an endless track;

a suspension frame configured to be removably mounted to at least one suspension beam;

a beam extending parallel to a direction of travel and pivotally coupled to the suspension frame about a first pivotal axis substantially perpendicular to the direction of travel;

a first idler wheel coupled to a forward portion of the beam and rotatable with respect thereto;

a second idler wheel coupled to a rearward portion of the beam and rotatable with respect thereto;

a belt tensioner configured to tension the endless track;

a drive wheel support fixed to the suspension frame;

a drive wheel rotatably coupled to the wheel support and having a drive wheel rotational axis, wherein the drive wheel is configured to be removably coupled to the drive wheel axle; and

wherein the belt tensioner is disposed to tension the track about the periphery of the drive wheel and the first and second idler wheels without transferring tension to the drive wheel axle.

8. The tracked suspension of claim **7** wherein the first and second idler wheels have first and second rotational axes extending in first and second vertical planes, respectively, wherein the drive wheel rotational axis is disposed above the first and second rotational axes of the first and second idler wheels and between the first and second vertical planes, and further wherein the first pivotal axis is disposed below the drive wheel rotational axis.

9. The tracked suspension of claim **8**, wherein the beam extending parallel to a direction of travel includes first and second ears extending upward from the horizontal beam, each of the first and second ears including a pivot at an upper portion thereof that defines the first pivotal axis.

10. The tracked suspension of claim **9**, wherein the tracked suspension frame includes forward and rearward brackets disposed at forward and rearward portions of the

suspension frame, respectively, wherein each bracket defines parallel mounting faces, wherein the parallel mounting face of the forward bracket is disposed to be fixedly mounted to the at least one suspension beam and the parallel mounting face of the rearward bracket is disposed to be fixedly mounted to at least another suspension beam extending from the vehicle.

11. The tracked suspension of claim **10**, wherein the wheel support includes a sun gear and a planetary gear.

12. The tracked suspension of claim **11**, wherein the wheel support includes a ring gear driven by the planetary gear.

13. The tracked suspension of claim **12**, further comprising inner and outer drive wheel bearings to support the drive wheel in rotation about the wheel support, wherein the ring gear, the sun gear and the planetary gear are disposed laterally between the inner and outer wheel bearings.

14. An agricultural tractor comprising:

front frame;

first and second front suspension beams extending from opposite sides of the front frame;

first and second front axles extending from opposite sides of the front frame;

an engine fixedly mounted to the front frame;

first and second front tracked suspensions mounted to the front frame, each of the first and second front tracked suspensions including:

an endless track;

a suspension frame mounted to one of the first and second front suspension beams;

an idler beam extending parallel to a direction of travel and pivotally coupled to the suspension frame about a first pivotal axis substantially perpendicular to the direction of travel;

a first idler wheel coupled to a forward portion of the idler beam and rotatable with respect thereto;

a second idler wheel coupled to a rearward portion of the idler beam and rotatable with respect thereto;

a belt tensioner configured to tension the endless track;

a drive wheel support fixed to the suspension frame;

a drive wheel operably coupled to one of the first and second front axles and rotatably coupled to the wheel support and having a drive wheel rotational axis; and

a drive wheel axle rotationally coupled to the drive wheel to drive the drive wheel in rotation;

wherein the belt tensioner is disposed to tension the track about the periphery of the drive wheel and the first and second idler wheels without transferring tension to the drive wheel axle;

a front differential fixedly mounted to the front frame to drive front tracked suspensions;

a transmission rotationally coupled to and driven by the engine;

a rear frame pivotally coupled to the front frame;

first and second rear suspension beams extending from opposite sides of the rear frame;

first and second rear axles extending from opposite sides of the rear frame;

first and second rear tracked suspensions mounted to the rear frame each of the first and second rear tracked suspensions including:

an endless track;

a suspension frame mounted to one of the first and second rear suspension beams;

an idler beam extending parallel to a direction of travel and pivotally coupled to the suspension frame about a first pivotal axis substantially perpendicular to the direction of travel;

a first idler wheel coupled to a forward portion of the idler beam and rotatable with respect thereto;

a second idler wheel coupled to a rearward portion of the idler beam and rotatable with respect thereto;

a belt tensioner configured to tension the endless track;

a drive wheel support fixed to the suspension frame;

a drive wheel operably coupled to one of the first and second rear axles and rotatably coupled to the wheel support and having a drive wheel rotational axis; and

a drive wheel axle rotationally coupled to the drive wheel to drive the drive wheel in rotation;

wherein the belt tensioner is disposed to tension the track about the periphery of the drive wheel and the first and second idler wheels without transferring tension to the drive wheel axle; and

a rear differential fixedly mounted to the rear frame to drive the first and second rear tracked suspensions.

15. A tracked suspension for use with a work vehicle having a drive axle and at least one laterally extending suspension beam, the suspension comprising:

a suspension frame configured to be removably coupled to the at least one suspension beam;

a drive wheel rotatably supported by the suspension frame and configured to be removably coupled to the drive axle;

a plurality of idler wheels rotatably supported by the suspension frame; and

a track supported by the drive wheel and the plurality of idler wheels.

16. The suspension of claim **15**, wherein the suspension frame includes a plurality of assembled components.

17. The suspension of claim **16**, wherein the suspension frame includes:

an idler wheel carriage adapted to be mounted to the at least one suspension beam;

an idler beam coupled to the carriage and supporting the plurality of idler wheels; and

a drive wheel support coupled to the carriage and rotatably supporting the drive wheel.

18. The suspension of claim **17**, wherein the idler beam is pivotably coupled to the carriage.

19. The suspension of claim **18**, wherein the suspension frame is configured to be coupled to the at least one suspension beam at one of a plurality of positions along the at least one suspension beam.

20. The suspension of claim **15** including a belt tensioner coupled to the at least one of the plurality of idler wheels and configured to move the at least one of the plurality of idler wheels relative to the support.

21. The suspension of claim **15**, wherein the plurality of idler wheels includes a first idler wheel and a second idler wheel having first and second rotational axes extending in first and second vertical planes, respectively, wherein the drive wheel rotates about an axis disposed above the first and second rotational axes of the first and second idler wheels and between the first and second planes, respectively.

22. The suspension of claim **15** including:

a sun gear adapted to be operably coupled to the drive axle;

a ring gear coupled to the drive wheel; and

a planetary gear coupled between the sun gear and the ring gear.

23. A work vehicle comprising:

a frame;

a drive axle extending from the frame;

a suspension beam extending from the frame; and

a suspension including:

a suspension frame coupled to the suspension beam;

a drive wheel rotatably supported by the suspension frame and operably coupled to the drive axle;

a plurality of idler wheels rotatably supported by the suspension frame; and

a track supported by the drive wheel and the plurality of idler wheels.

24. The vehicle of claim 23, wherein the suspension frame is removably coupled to the suspension beam.

25. The vehicle of claim 23, wherein the suspension frame is removably coupled to the suspension beam for movement between a plurality of positions along the suspension beam.

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